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Masonry Construction Work at the Kensico Dam in 1913

By Wilson Fitch Smith*

The excavation and foundation work for the Kensico Dam, now being built as a part of the Catskill water-supply system, New York City, was described in an article by the writer published in Engineering News, of April 9, 1914. The present article will describe the masonry work for the main dam, which is of cyclopean masonry, or concrete with large stones embedded in it. The story is largely told by the accompanying views and line drawings and the subtitles accompanying the views. The first view, Fig. 1, shows the masonry work in the gorge on May 14, near the beginning of the active masonry operations for the year and the last two views, Figs. 11 and 12, show the status of masonry construction on the dam proper at the close of the year. For the convenience of the reader, the maximum cross-section of the dam, as given in the former article mentioned, is repeated here as Fig. 13. The longitudinal profiles of the dam at various intersections are shown by Fig. 10, which also shows monthly progress with the masonry during 1913.

Fig. 1. General View of Gorge Looking Upstream, Showing Portion of Cyclopean Masonry in Place; May 14, 1913

(Concrete at foot of ladder in foreground is about Elev. +80. Surface water is collected in pipes and flumes and led away from fresh concrete.)

The most novel feature in the construction of the Kensico Dam is the arrangement of plant for handling and placing rapidly the large quantities of masonry. In the construction of most of the large dams up to the present time, both rubble and concrete, the overhead cableway has played an important part in delivering the masonry to the placing derricks, and the speed of construction has been rigidly regulated by the capacities of the cableways. At Kensico Dam, the cableways are used only for handling plant and incidental work. The fundamental idea is the delivery by rail, within reach of the placing derricks, of all masonry and other materials.

For constructing the main portion of the dam, stiff-leg derricks mounted in pairs on travelers are used, as shown in a number of the views and in the plan, Fig. 2. These travelers operate on a system of elevated tracks, supported on concrete piers about 20 ft. high. Two lines of traveler tracks running longitudinally with the dam permit four travelers to be placed in pairs facing each other over a section of the dam between expansion joints, thus making eight derricks available for each section of the dam. Between and on the outside of the traveler tracks are service tracks, upon which shuttle cars bring the concrete in bottom-dumping buckets, of 2-cu.yd. capacity, from the mixers located at the ends of the dam. The piers carrying the traveler tracks are 4 ft. square on top and 6 ft. square at the base, and are formed in place of mass concrete. They are spaced longitudinally about 40 ft. apart, or half the length of the section, and transversely 30 ft. apart, and support girders of 28-in. Bethlehem H-beams, which carry the rails directly. The travelers are each equipped with two 57-ft. booms and 75-hp. double-speed electric hoists. The service tracks are similarly supported on concrete piers 18 in. square on top and 3½ ft. square at the base. These piers are made in the block yard and erected by the cableways. They carry timber floor-beams, which support the track stringers, which are 24-in. Bethlehem H-beams. The large cyclopean stone is delivered to the outside derricks by tracks on the refill on both the upstream and downstream sides of the dam.

The concrete blocks serve as forms on the upstream face and transverse expansion joints. Wooden forms are used on the downstream face below the surface of refill. One section of the dam is constructed by placing masonry

*Division Engineer, Southern Aqueduct Department, Kensico Division, Board of Water Supply, City of New York, Valhalla, N. Y.

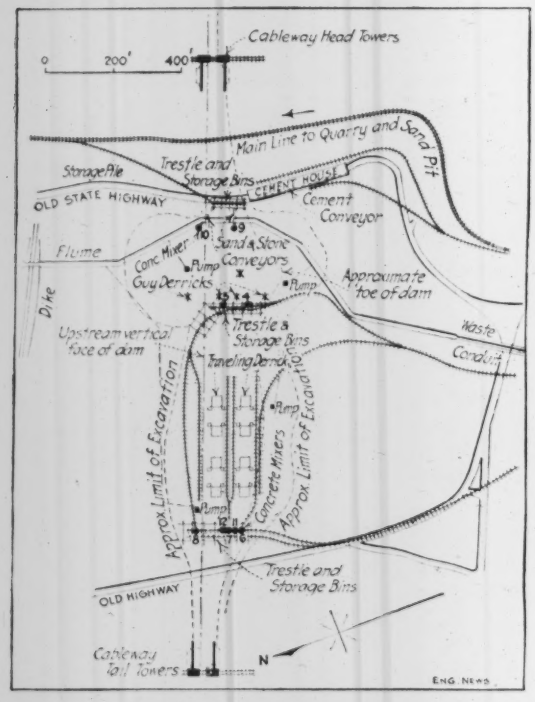
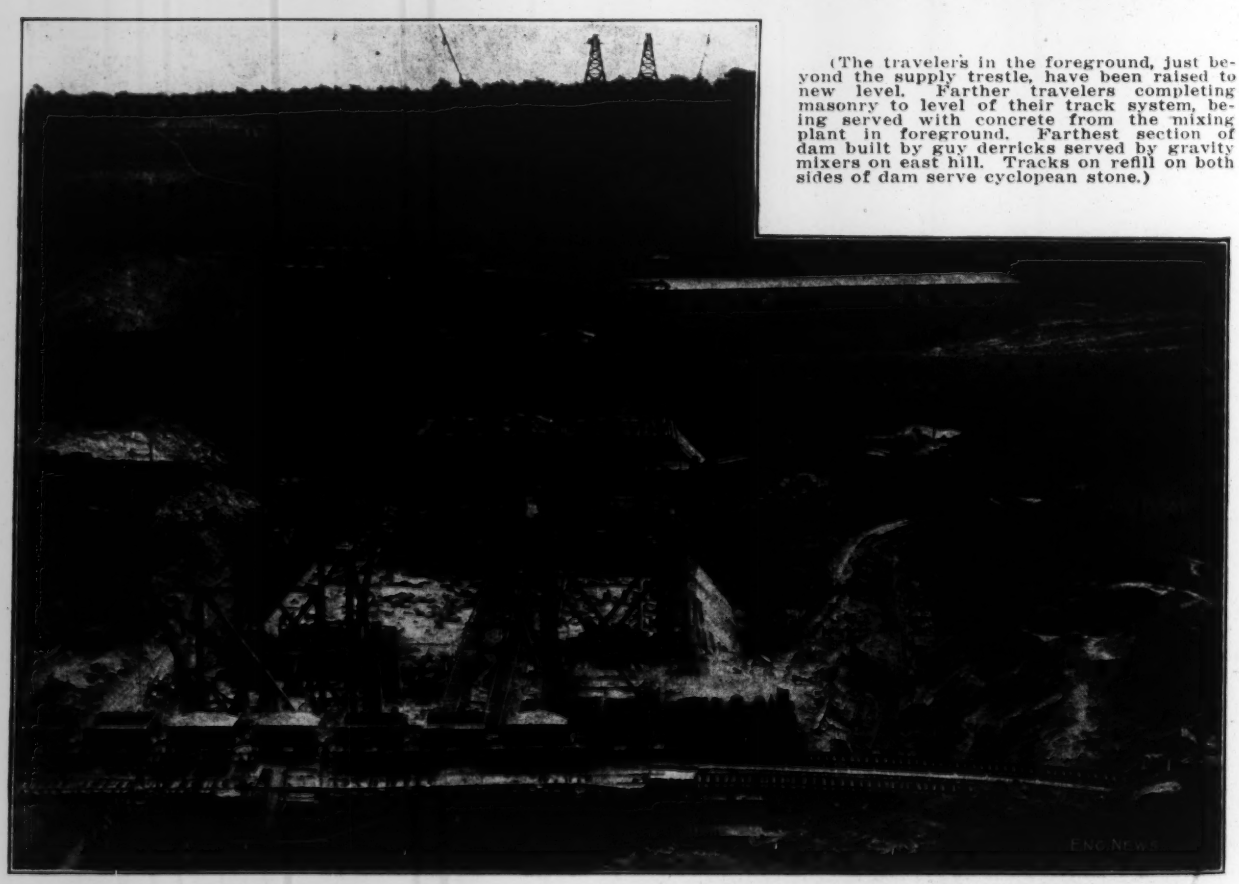


FIG. 2. TYPICAL ARRANGEMENT OF CONCRETE MIXING AND PLACING PLANT

FIG. 3. DETAIL VIEW, LOOKING WEST, OF PLANT FOR PLACING CONCRETE, APR. 22, 1913

(Two traveler tracks and service tracks are elevated on piers. The piers are to be embedded in the dam and new ones built as the work progresses. Three travelers have been erected. The traveling crane is on a supply trestle back of the travelers. Within the trestle are three concrete mixers. Consult plan, **Fig.** 2, for further details of plant arrangement.)



(The traveler's in the foreground, just beyond the supply trestle, have been raised to new level. Farther travelers completing masonry to level of their track system, being served with concrete from the mixing plant in foreground. Farthest section of dam built by guy derricks served by gravity mixers on east hill. Tracks on refill on both sides of dam serve cyclopean stone.)

FIG. 4. GENERAL VIEW OF DAM FROM WEST HILL AT ELEVATION OF FLOW LINE, LOOKING EAST, SEPT. 17, 1913

CONTRACTOR'S PLANT AND CONSTRUCTION WORK ON THE

FIG. 5. VIEW OF DOWNSTREAM SIDE OF DAM, LOOKING NORTHEAST, OCT. 30, 1913

(Shows travelers, traveler track and supporting piers for placing concrete to Elev. 214.5; refill to Elev. 192 in foreground, with tracks for bringing in large stones to be embedded in concrete. Forms for concrete facing may be seen at foot of slope. Refill covers this face to Elev. 240 above which it will be finished with cut stone masonry.)

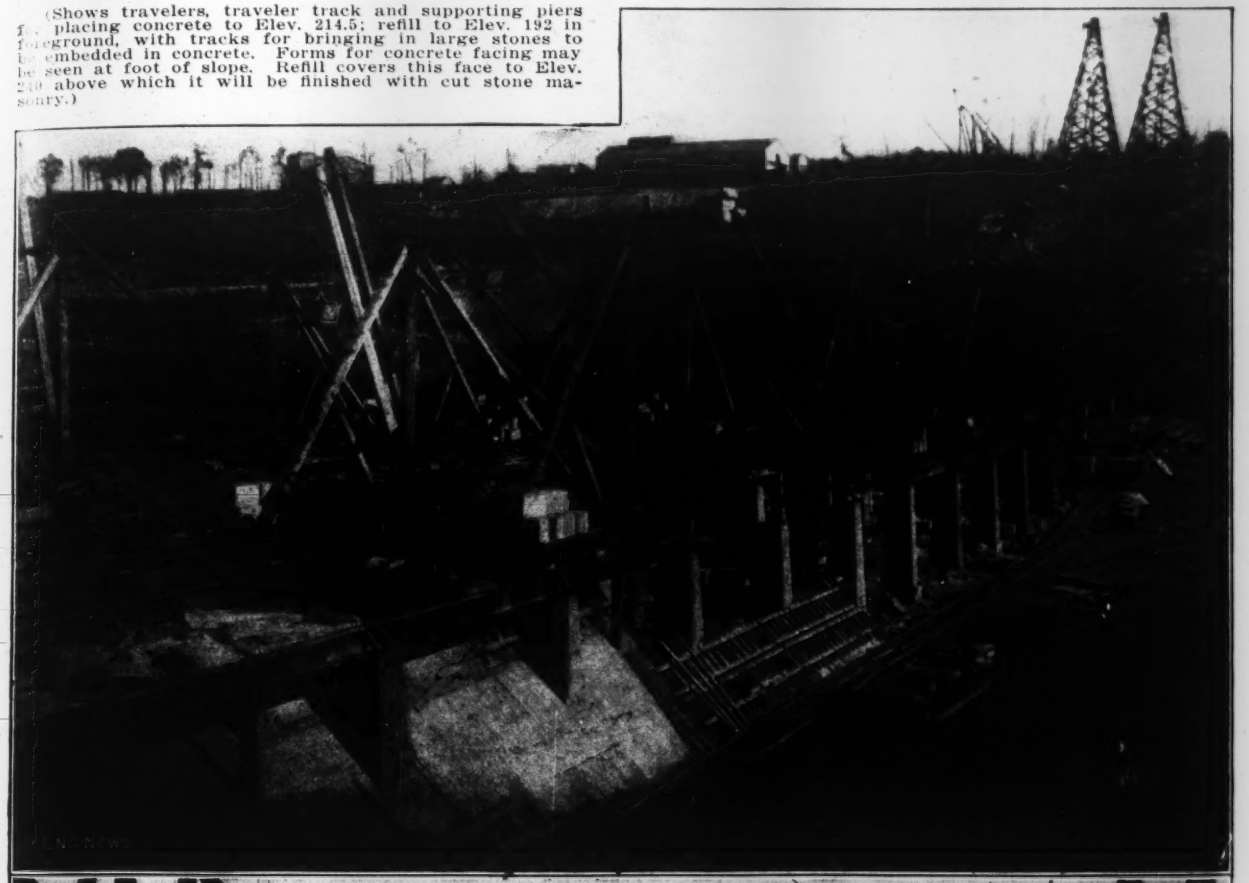


FIG. 6. VIEW OF UPSTREAM SIDE OF DAM, LOOKING SOUTHWEST, OCT. 30, 1913

(Shows travelers, track and supporting piers for placing material in several lifts of masonry between Elev. 192.5 and 214.5. Each section between expansion joints is built to the level of the traveler tracks successively. Concrete mixers are located within trestle in right foreground.)

KENSICO DAM, CATSKILL WATER-SUPPLY, NEW YORK CITY

on successive days until the masonry rises to the tops of the concrete piers carrying the tracks. The travelers are then moved to the next section. Two groups of travelers make it possible to place masonry at two sections simultaneously. The travelers were used for placing all of the masonry west of the gorge.

After the masonry had been completed up to the base of the traveler tracks, these were reconstructed at a higher level, the piers resting on the top of the first lift. The travelers and other moving plant were readily lifted to the higher level by the cableways and adjacent derricks. Two lifts have brought the masonry up to Elev. 214.5.

The portion of the dam in the gorge up to Elev. 21[illegible] ft. was placed entirely with guy derricks, which at fi[illegible] were mounted on the sides of the gorge and later on c[illegible] crete piers which were incorporated in the dam as [illegible] masonry rose around them. On Dec. 20, 1913, when [illegible] placing of masonry was suspended for the season, [illegible] dam was completed to Elev. 214.5 ft. in eleven sectio[illegible], or a length of 859 ft. (see views, Figs. 11 and 12). T[illegible] next lift, to Elev. 240 ft., will permit the use of travele[illegible] for this entire length, guy derricks being used to co[illegible] struct the closure at the ends against the rock founda[illegible] tions of the sloping hillsides. The width of the da[illegible] above Elev. 240 ft. will permit of only one traveler track,

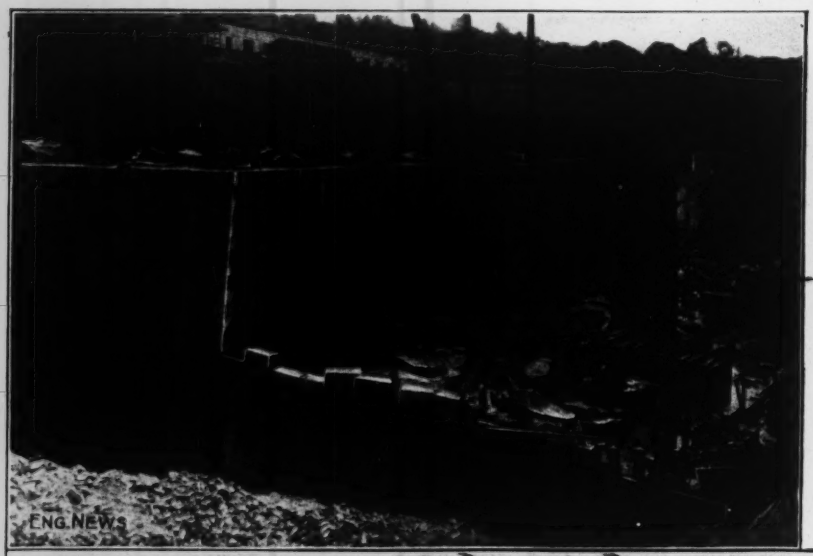


FIG. 7. UPSTREAM FACE OF KENSICO DAM AT GORGE, SHOWING EXPANSION JOINTS BETWEEN SECTIONS, LOOKING SOUTHEAST, SEPT. 17, 1913.

(Section at left is finished to Elev. 194.5 or 130 ft. above the foundation.)

FIG. 8. GENERAL VIEW OF KENSICO DAM, LOOKING SOUTHWEST, OCT. 30, 1913

(The top of the dam will be 5 ft. above the base of the cable tail towers. The track on the left serves the concrete aggregate bins; the materials from these bins are carried on belt conveyors to the bins over the gravity mixers, one of which is in the left middleground.)

but the increasing length of the masonry will provide more sections, so that there will be but little reduction in working area until the upper portion of the dam is reached.

The lower portion of the gorge was served by two 1-yd. rotary mixers in a trestle which crossed the dam site at the west side of the gorge. Later two gravity mixers of 2-yd. capacity were installed on the east side of the gorge. The traveling derricks were served by three gravity mixers mounted in a trestle at the west end of the dam site.

FIG. 9. GENERAL VIEW OF KENSICO DAM FROM BASE OF WEST HILL, OCT. 30, 1913

(The concrete mixing and handling plant is again shown, as well as the tracks for delivering the cyclopean stone on both sides of the dam. Note the excavation for the cutoff in the left foreground, and just above it the arrangement of the concrete blocks at the inspection well. The copper strip water stop will be placed in the joint between sections adjacent to this well.)

When the masonry rose to such a height that the middle mixer could no longer serve the shuttle cars, it was replaced by two rotary mixers, which slightly increased the output of the plant.

Subsequent work involves the relocation of the mixing plants at higher levels, but the advantage of this method over the permanent concrete plant at a distance is the delivery of the concrete to the placing derricks with the shortest possible lapse of time after mixing. This prevents the concrete materials from segregating in the buckets and minimizes the labor of placing the concrete. During the early part of the work, the mixers were served with crushed stone and sand from storage bins by gravity. The mixers at the higher levels will be served from storage bins by belt conveyors. Cement in bags is delivered to the mixers by gravity chutes directly from the freight cars, which are run in on spur tracks. To provide for the possible interruption in the cement supply, which averages 10 carloads a day, a storehouse of 15,000 bbl. was constructed on the east hill and connected with the east hill mixers by a belt conveyor.

The first masonry was placed in the dam on Apr. 23, 1913, but the plant was not sufficiently installed to enable general work until June. The following table shows the quantities of masonry placed each month during 1913:

Month	Cu.yd.	Month	Cu.yd.
April	890	October	44,[illegible]
May	9,240	November	48,[illegible]
June	30,060	December	38,[illegible]
July	42,300		
August	48,290	Total	316,[illegible]
September	53,240		

Between Apr. 23 and Dec. 20, 1913, a total of 316,000 cu.yd. of masonry were placed in the dam. Of this, [illegible] 400 cu.yd. were concrete blocks. This was accomplished in 200 working days of eight hours each. During the busiest part of the season the blocks were set at night, adequate lighting being provided. In the month of September, 53,240 cu.yd. of masonry were placed in 25 days, and the best daily record was 2250 cu.yd. The cyclopean stone amounts to 27.5%, many single stones running as large as 10 cu.yd.

The proportions of concrete in the cyclopean masonry were 1:3:6, and the cement factor to date is 0.83 bbl. per cu.yd. of cyclopean masonry.

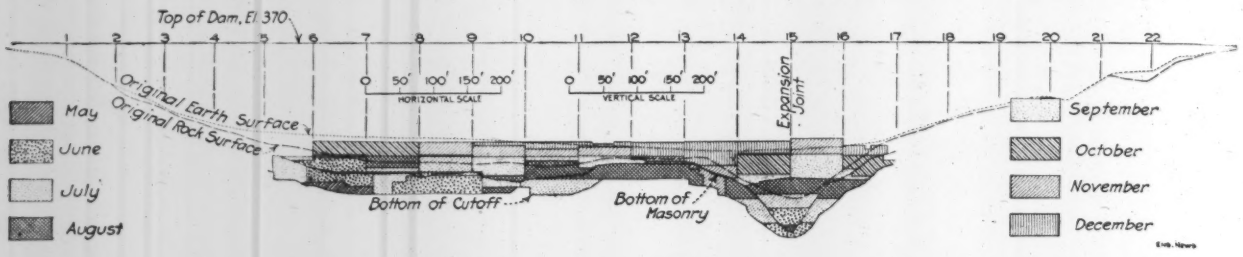


FIG. 10. LONGITUDINAL PROFILES OF KENSICO DAM, SHOWING PROGRESS IN PLACING MASONRY DURING 1913

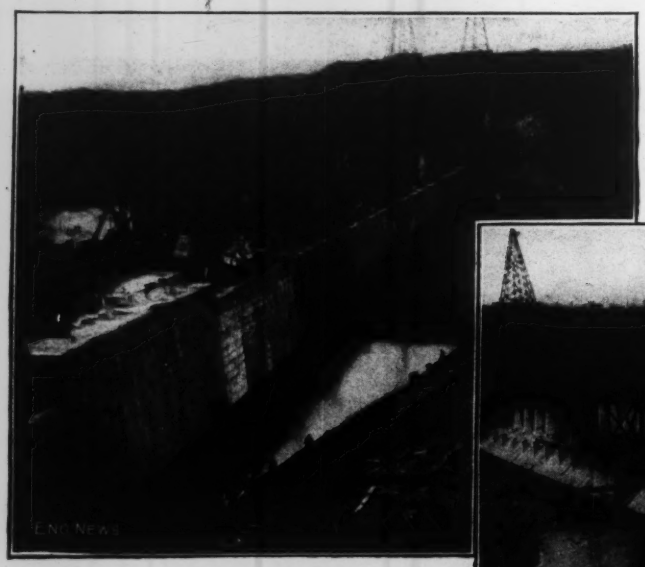


FIG. 11. UPSTREAM FACE, LOOKING WEST, DEC. 19, 1913

In the foreground refill is being placed in the deep excavation of the gorge.

FIG. 12. DOWNSTREAM FACE, DEC. 31, 1913

The masonry has reached Elev. 214.5. In the right foreground is the lower portion of the culvert through the dam, to which the flume in the foreground will be connected to take care of local drainage during the remainder of the construction.

VIEWS OF THE KENSICO DAM TAKEN BY THE CONTRACTOR TO SHOW STATUS OF WORK AT CLOSE OF 1913 SEASON

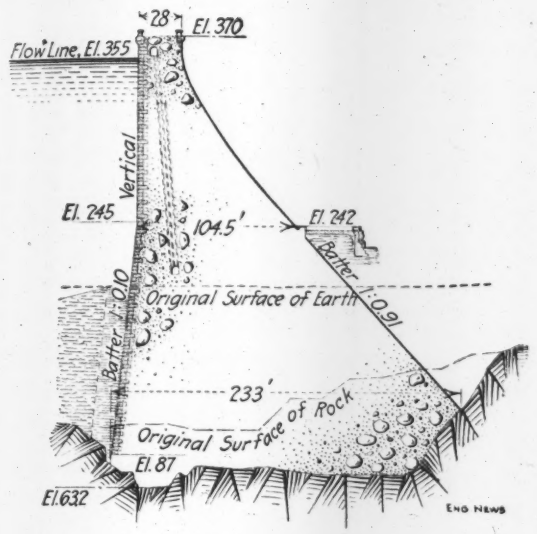


FIG. 13. MAXIMUM CROSS-SECTION OF KENSICO DAM

In order to assure the best possible seal in the cutoff trench, the upstream half of its width was filled with mass concrete mixed in the proportion of 1:2:4.

Before placing the masonry on the rock foundation, the surface was scrupulously cleaned and washed with jets of air or water under high pressure, and every loose fragment of rock was removed by barring and wedging. A thin mortar coat was spread on the surface so prepared before placing any concrete.

The successful accomplishment of the above-stated results, requiring the daily delivery of from three to four thousand tons of materials to certain concentrated areas, was largely a problem in transportation, and depended upon the high grade of tracks and rolling equipment as well as the efficient and well coördinated working force of the contractor. The latter averaged about 950 men for the year, reaching a maximum of 1200 in August.

The work is being done for New York City under the supervision of the Board of Water Supply, of which J. Waldo Smith is chief engineer and Frank E. Winsor, department engineer. Beverly R. Value is chief engineer and George H. Angell is superintendent for the contractor, H. S. Kerbaugh, Inc., 6 Church St., New York City.

American Port and Harbor Work

SYNOPSIS—Harbor engineering is a branch of the profession which has developed materially in this country within recent years, due to commercial conditions, and the accompanying article briefly reviews some of this work now in progress and contemplated at the larger seaports.

A class of engineering work which is growing in extent and importance in this country is the work of improving our ports and harbors, both as to the waterways themselves and as to the various facilities for the accommodation of shipping and railway traffic. This is due to the increase in commerce, the increase in size of vessels, and the increasing demand for improvements which will tend to higher efficiency and economy in the handling of business. As the result of a recent inquiry concerning developments in this line of engineering we give below a brief summary or review of some of the more important work of 1913 and 1914.

The dredging of ship channels and in the main part of the waters of a harbor is done mainly by the Federal Government, which also undertakes the construction of breakwaters, jetties, etc. This work is under the direction of the U. S. Corps of Engineers (War Department). Dredging for docks or slips and for the shallower waters is done mainly by local authorities or by private concerns which lease or own waterfront property. The provision of piers, freight sheds, warehouses and other facilities is done partly by municipal authorities and partly by railway and shipping companies. In Rhode Island, Massachusetts and California, harbor improvements are assisted largely by special state authorities, on the principle that such work is of more than local importance. Many cities having important work of this kind put it under the direction of a special board or commission; examples of this practice are New York, Philadelphia, New Orleans, Portland (Ore.), Los Angeles and Seattle.

NORTH ATLANTIC PORTS

PORTLAND, ME.—The work of importance during 1913 consisted in dredging the lower part of the main harbor to give a depth of 30 ft. at mean low water. Work has been commenced on dredging (to the same depth) a considerable anchorage area opposite the eastern end of the city, and in removing about 2700 yd. of ledge obstructing the channel at the entrance to Back Cove. The dredging is by contract, but the ledge work is being done by the U. S. Engineers with hired plant, working by the day.

PROVIDENCE, R. I.—The work of harbor improvement is being conducted in two parts: one by the State, under the direction of the State Harbor Improvement Commission; the other by the city, under its engineering department. The work done by the State during 1913 included the completion of Pier No. 1, 120x600 ft., which is now in use by ocean steamships. The cost of pier and steel shed complete will be nearly $500,000, of which $268,760 was expended in 1913. The shed is now under construction. The work contemplated for 1914 will cost about $267,000. Plans have been prepared for the improvement of the State's property in Pawtucket by constructing a quay wall about 700 ft. long, with a steel shed and considerable filling to grade the area back of the wall. This improvement will cost about $150,000.

The work being carried out by the city was begun in 1912 and consists of the construction of a granite quay wall 3000 ft. long, with foundation placed at a depth sufficient to allow for a depth immediately in front of the wall of 30 ft. at mean low water. The total cost of this work, including land purchased, will approximate $750,000, of which about $259,000 was expended in 1913. There will probably be expended in 1914 about

$110,000. During 1913, the U. S. Government carried on dredging operations, consisting mainly of widening the 25-ft. channel and removing shoals. The deepening of the channel from 25 ft. to 30 ft. at mean low water was authorized by the U. S. Government, and an initial appropriation made in 1913; it is expected that this work will be put under contract and be begun this year.

BOSTON, MASS.—During the past year the government has been cleaning up small shoals left by the dredging in the main ship channel between President Roads and Broad Sound, and excavating rock in the main channel between President Roads and the city. Practically all the dredging to secure the 35-ft. channel has been completed, with the exception of clearing up the small shoals left by the dredge and the removal of rock, which will take some time.

The government engineers are making surveys also to determine the best location and estimated cost of excavating the main channel in the harbor to the depth of 40 ft. between President Roads and the city and 45 ft. between President Roads and the sea. The extra depth in the entrance channel is due to the fact that this channel is in an exposed location where the heavy seas cause the vessels to pitch, so that a greater actual depth is required to give the same navigable depth.

The work of the Commonwealth during the past year was fully treated in ENGINEERING NEWS, Apr. 2, 1914 and the general work on the improvement of the port was described in the issue of Nov. 2, 1911.

NEW YORK, N. Y.—The work under the direction of the city's Department of Docks and Ferries during 1913 may be summarized as follows: The wharfage space owned by the city was increased 3500 ft. by the extension of the permanent bulkhead or sea wall (of granite or concrete) and by the construction of several new piers. From the Battery to Gansevoort St., the North River pier-head line has been extended by the U. S. Government, permitting the lengthening of about 30 piers by 50 to 200 ft. Work was in progress also on the steel and concrete ferry-house and coal pocket at the foot of 39th St., South Brooklyn.

Dredging for the 1000-ft. pier in the North River, at 46th St., was commenced. The dredging for a channel 500 ft. wide and 18 ft. deep in Jamaica Bay, leading north about 8000 ft. from Barren Island or the main channel, has been completed, this being the first step in the Jamaica Bay Improvement. The spoil from this work was deposited on the adjoining marshes and land under water behind a temporary sheet-pile bulkhead, and forming a continuous stretch of land about 7000 ft. in length and averaging about 700 ft. wide.

The Department maintains a large force and equipment consisting of 21 piledrivers, and numerous tugs, derricks, scows, etc. Acting under an appropriation called the budget for maintenance and repairs, amounting to about $2,500,000, this force will be employed during 1914 all over the waterfront and mainly upon repairs to the city's piers (over 200 in number), repairs to pavement, etc. In addition to this repair work, new projects are under consideration for contract.

It is the intention to finish dredging at the foot of West 46th St., and build the coffer-dam, and excavate the rock under water dry at the inner end of this pier, and eventually finish the 1000-ft. pier for the large transatlantic steamers. The extension to the various piers between the Battery and Gansevoort St., on the North River, will be finished during 1914, and a number of others will be started during the year, some being constructed by the Department, and some let by contract, while others will be built by the lessees under their own contracts at their own expense.

In what is known as the Gowanus Section, on the South Brooklyn waterfront between 28th and 36th Sts., the city has finished two of the longest piers built (about 1700 ft.) and completed ½ mile of permanent bulkhead wall, reclaiming the land for a distance of 500 ft. outshore from Second Ave. These two piers are now equipped with sheds and leased, and the city proposes to continue with pier construction in this district. The Commissioner of Docks has under consideration the project for building in this section a dry dock 1100 ft. long, sufficient to accommodate the largest steamers using this port, and which at present have no dry-docking facilities in case of emergency or accident.

The city has also under contemplation, through the offices of the Committee of the Board of Estimate and Apportionment, the construction of a terminal freight railway which will connect the New York Dock Co. (or the Brooklyn Bridge section of Brooklyn) with the Bush Terminal Co., situated in the lower bay in the neighborhood of 40th St., Brooklyn. The object of this is to concentrate the railway business at a central terminal float station, with a central classification and distribution yard for freight cars, connecting the large dock companies at both ends of the line, and eventually stimulating the building of factories and further development for this whole 5½-mile stretch of Brooklyn waterfront.

The pier and dock improvements on the western or New Jersey side of the harbor are mainly in the hands of transportation and other private companies. But the State owns the "flats" along the west side of the bay between Jersey City and Staten Island, and the New Jersey Harbor Commission, acting together with the New York Harbor Board, has projected developments here, consisting of land reclamation to form extensive piers and facilities for a rail and water terminal.

The U. S. Government has now practically completed the Ambrose channel, the main deep-water entrance to the harbor. This is about 7 miles long and 2000 ft. wide, with a depth of 40 ft. at mean low water, permitting a maximum draft of 37 ft. It also has been dredging the entrance to Jamaica Bay and completing the Bay Ridge channel to the full width of 1200 ft. and depth of 40 ft.; also improving the East River to a 26-ft. depth. The maximum draft that can be carried through the channels from the ocean to the northern limits of the city is not less than 40 ft. at mean low water and this depth has been made available along a considerable part of the New Jersey waterfront, greatly facilitating the transatlantic steamer service on that side of the Hudson River.

PHILADELPHIA, PENN.—The U. S. Government has continued work of excavation under the adopted project for a 35-ft. channel at low water from Philadelphia to deep water in Delaware Bay, a distance of about 63 miles, and the dredging is now practically completed from the southerly end of the harbor to Chester, about 18 miles. The city, with some assistance from the State of Pennsylvania, has deepened the channel of the Schuylkill River during the past year. The cost of the improve-

ment of this river is not participated in by the Federal Government. Due to this dredging, the existing depths at mean low water are from 30 ft. at the entrance to the Back Channel to 20 ft. at Harrison's Wharf.

During the present year the Government will continue work on the 35-ft. channel and complete the dredging of about half of the harbor to the full projected length. The municipal dredging plant will continue the dredging of the docks along the Delaware River front, and the deepening and widening of the channel of the Schuylkill River, from its mouth to the head of deep water navigation at Walnut St., a distance of about 7 miles.

During 1913, six piers were completed at a total approximate cost of $2,225,000. These new piers, together with the present piers and bulkheads, give a total available berthing space of 162,656 lin.ft., of which about 35,000 ft. is available for ships of 26- to 28-ft. draft. During 1914, the municipality expects to complete two additional steamship piers, at an approximate cost of $1,000,000 each, and has sufficient funds in hand to commence the construction of one additional pier, 250x900 ft., the first of a group of long, wide, double-deck modern structures. The entire program of port improvement involves an expenditure of nearly $25,000,000, covering work which will extend over a period of several years.

BALTIMORE, MD.—The dredging operations for 1913 in the harbor amounted to 404,517 cu.yd. Work was started for the construction of a double-deck pier, to be completed in March, 1914, to cost $1,000,000. Also, the construction of a water-front street 106 ft. wide, the first section to be completed this spring at a cost of $750,000. These figures include cost of property purchased. The city contemplates the widening and deepening of the channels of the harbor (about 3,855,573 cu. yd.), and a number of large improvements, including land reclamations, new piers, and the Light St. Bridge. There is also being considered the development of another part of the harbor known as Spring Gardens; this improvement will cost $1,500,000, not including the cost of property.

No work was done by the Government upon the Baltimore ship channel during 1913, except survey work which showed that the 35-ft. channel is maintaining itself in satisfactory manner, there being no shoaling which required attention. The River and Harbor act, of 1913, made an appropriation for widening the York Spit channel from 600 ft. to 1000 ft., and this is under contract. This portion of the channel is in the lower end of Chesapeake Bay, opposite the mouth of York River, Virginia, and cuts through a shoal where the depth was less than the 35-ft. provided for Baltimore harbor and approaches.

SOUTH ATLANTIC AND GULF PORTS

NORFOLK, VA.—No government work was done on the ship channels, but the Thimble Shoal channel is to be completed to a depth of 35 ft. for a width of 500 ft., and the Western Branch channel will be enlarged to 300-ft. width and 24-ft. depth. Some of the transportation companies built new piers and freight houses, the most important of these works being the coal pier of the Norfolk & Western R.R., at Lambert's Point. (ENGINEERING NEWS, Apr. 23, 1914.)

WILMINGTON, N. C.—The government continued work on the 400-ft. channel across the bar, and has now the full depth of 26 ft. for a width of 150 to 400 ft., the latter being the intended width.

CHARLESTON, S. C.—During 1913, dredging was in progress with the government sea-going dredge "Sumter" to form a channel 28 ft. deep at mean low water (33 ft. at high water), 1000 ft. wide outside the jetties and 500 ft. wide within the jetties. The channel now has a minimum width of 600 ft. beyond the jetties and 500 ft. within the jetties. Railway terminals, with piers, etc., are to be built by the Carolina, Clinchfield & Ohio R.R.

SAVANNAH, GA.—The government has continued the work on the deep-water channel from the docks to the sea, and expects to complete this in 1914, giving a depth of 26 ft. at mean low water. The work contemplated for 1914 includes maintenance dredging and the creation of a turning basin sufficient for ships 800 ft. long, at an estimated cost of $154,000. The Merchants & Miners Transportation Co. has completed new terminals, with large storehouses and a concrete-faced dock. The Central of Georgia R.R. is expending about $1,000,000 in improving its terminal facilities, and the Seaboard Air Line Ry. is planning similar work. The city has purchased wharf property and expects to build a municipal dock 350 ft. long.

BRUNSWICK, GA.—In 1913, the Southern Ry. made extensive improvements at its terminals in the way of buildings and docks, and the Atlanta, Birmingham & Atlantic Ry. also had considerable dredging and improvements made at its docks, while the Georgia Coast & Piedmont Ry. intends improving its dock property this year. The government also had some dredging done.

MOBILE, ALA.—The government improvement work here is mainly dredging on a channel 30 ft. deep for ¾ mile across the outer bar and 27 ft. in the bay and river, with a width of 200 ft. for 28½ miles in the bay and 300 ft. for 5 miles in the river. At present the available depth in the latter case is only 26 ft. At the head of the channel a turning basin 600x800 ft. will be dredged.

GULFPORT, MISS.—During 1914, the dredge "Gulfport" will work on the widening and deepening of the channel and anchorage basin, increasing the depth from 21½ ft. to 26 ft. The Gulf & Ship Island Ry. is building a water-front warehouse of steel and concrete, which will be 75x1000 ft., divided by fire walls at intervals of 200 ft.

NEW ORLEANS, LA.—The Board of Port Commissioners during 1913 started the construction of the Pauline St. wharf, which is 1530 ft. long, and has cost $239,380. This will be completed in 1914. The most important work contemplated for 1914 by the Board is the erection of cotton warehouses and terminals, to be located on the river front between Napoleon Ave. and Soniat St., for which $3,000,000 worth of bonds have been issued. The Board has installed a banana conveyor at a cost of $33,320.

Bank revetment work was done by the government in New Orleans harbor for 4000 lin.ft., 300 ft. wide, at an approximate cost of $100,000; another stretch of 4000 ft. will be built this year. The government also spent about $100,000 in the maintenance of the South Pass and Southwest Pass by dredging; and will continue this work by dredging and additions to the jetties to keep them above mean water level. These passes are 105 and 110 miles below the city.

GALVESTON, TEX.—Repair work on the outer end of the South Jetty is in progress, and the 30-ft. Galveston

channel is to be widened to 1200 ft. at its outer end. The 60-mile ship channel or canal from Galveston Bay to Houston is to be completed to the full depth of 25 ft.

TEXAS CITY, TEX.—Contracts have been let for enlarging the approach channel by dredging, giving a channel 30 ft. deep and 200 ft. wide instead of 25 ft. deep and 100 ft. wide. This will cost about $1,100,000. A contract has also been let for a pile dike along the side of this channel at about $300,000. The Texas City Terminal Co. is planning dock extensions.

PACIFIC PORTS

There has been exceptional activity in the development of facilities of ports on the Pacific Coast, due to the expected increase of commerce following the opening of the Panama Canal.

SAN DIEGO—The new pier, bulkhead wharf and harbor dredging described in ENGINEERING NEWS, Mar. 13, 1913, is progressing favorably and in April, 1914, was nearly 30% complete.

LOS ANGELES, CAL.—At San Pedro, which is now annexed to Los Angeles and constitutes its port, the government is dredging some of the docks and a part of the East Basin to 30 ft. The city carried out some important improvements, as follows: dredging channels, building dikes and filling land, $524,000; creosoted pile and timber wharves and bulkheads (2270 ft. and 3400 ft.), $183,000; concrete wharves (2250 ft.), $480,000; steel freight shed, 1800 ft. long, $268,000; wood freight shed (with fireproof covering), 1000 ft. long, $138,500; also railway, street and sewer work in connection with these improvements, about $186,500.

Practically all of the above work will be completed in 1914. In addition, it is planned to issue bonds for $2,500,000 for about 2000 ft. of concrete wharf, 4000 ft. of timber wharf, freight sheds, railway tracks, etc. Besides this municipal work, the Outer Harbor Dock Co has constructed docks and reclaimed land by filling on the southwest side of San Pedro Bay, just inside the breakwater. The two slips or docks already completed are 280 ft. wide and 1200 ft. long.

SAN FRANCISCO, CALIF.—During 1913, the government completed a dredged channel 5½ miles long, through San Pablo Bay (an extension of San Francisco Bay); this has 30 ft. of water for a width of 500 ft., giving ample facility for vessels going to Mare Island and interior points. Work was in progress also in dredging the Oakland harbor channel to the same dimensions for a length of about 8 miles, and this will be completed in 1914. The State Harbor Commissioners built six piers, 126 to 200 ft. wide and 675 to 900 ft. long; these have reinforced-concrete cylinder piers and deck (except that one has wood piles incased in concrete), with sheds of wood, steel and concrete. These cost about $3,000,000.

Work was commenced also on a seawall composed of a rock fill with concrete retaining-walls and bulkhead or wharf. It is proposed to build two ferry slips for car-transfer boats, five slips for passenger ferry steamers, and seven piers 200x900 ft., the piers having timber sheds.

PORTLAND, ORE.—The U. S. Government and the port authorities have four dredges at work on the project for a 30-ft. channel to the mouth of the Columbia River, the present depth being from 28 to 29 ft. The government has completed two new 24-in. suction dredges for this work. At the mouth of the river the government dredge "Chinook" was operated for about three months and deepened the bar channel about 2½ ft. This dredge has two 20-in. suctions, but will have the capacity greatly increased by installing two additional 30-in. pumps. The city (by its Commission of Public Docks) during the year commenced the construction of municipal docks and at the close of the year had under contract one dock 663 ft. long, and had completed a motor-boat landing of fireproof construction costing about $21,000. It is proposed to build another municipal dock 525 ft. long and to increase the first one to a total length of 1075 ft.

This pier and dock construction is being built under a bond issue of $2,500,000, authorized in November, 1910. The Commission of Public Docks has under consideration a plan for the construction of two pier and slip developments, the estimated cost of which is in the neighborhood of $14,000,000, but before the property can be obtained and the construction commenced, it will be necessary to ask for authority to sell additional bonds. The portions of these pier and slip developments which will be undertaken in the immediate future will cost approximately $4,000,000.

SEATTLE, WASH.—Extensive improvements are planned here under the direction of the Port Commission, and a bond issue of $7,000,000 has been authorized for the purpose. The project provides for docks, slips, warehouses, etc., at six separate points in the harbor, but more than half the expenditure will be on the East Waterway, which is designed to accommodate ocean steamers. In addition, the Duwamish River is being improved for a length of about four miles through a district suitable for industrial development, while the canal and lock connection with Lake Washington will eventually make this lake a fresh-water auxiliary of the harbor.

A Booster Pump at Malone, N. Y., for Increasing Water-Works Supply-Line Capacity

An interesting case of the use of a motor-driven centrifugal booster pump in small water-works service, for increasing the delivery capacity of an existing supply-line is seen in an installation recently made in the village of Malone, N. Y.

The source of supply is seven or eight miles south of the village in spring-fed brooks. In 1888, the Malone

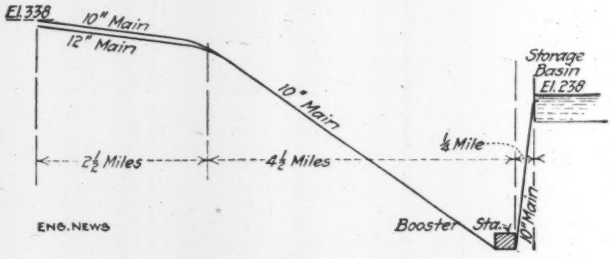
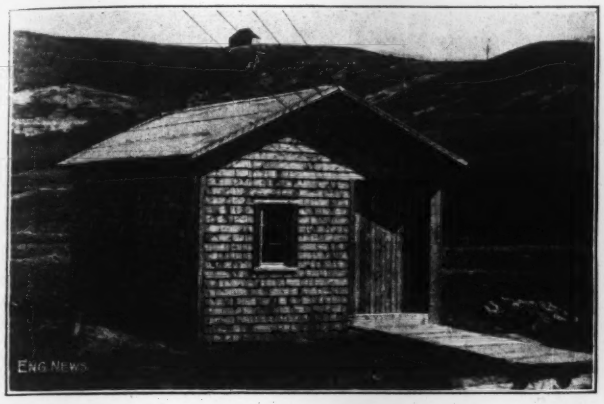


FIG. 1. DIAGRAMMATIC PROFILE OF MALONE WATER-SUPPLY MAINS

Water Co., which installed the system, ran a 10-in. line to a storage basin near the town. In 1906, the village purchased the plant and shortly after reduced the rates. As a result, a large number of people improved and increased their water conveniences, so that the consump-

tion rose rapidly. In about three years, the village trustees found that there was not water enough to supply the demand. Thereupon, $25,000 was raised to lay 2½ miles of a parallel 12-in. main connecting with the original 10-in. pipe at the end of this distance. This additional line was estimated to increase the delivery of the 10-in. pipe (900,000 gal. per 24 hr.) by about 10%. This increase did serve for a couple of years more when a shortage was again faced. The next extension of the 12-in. line would have cost about $70,000 and the trustees did not like to call for more money as the 12-in. addition was not all paid for.



FIGS. 2 AND 3. EXTERIOR AND INTERIOR OF MALONE BOOSTER PUMPING STATION

At this juncture, the superintendent of the waterworks, Geo. A. Willson, proposed to use a booster pump in the existing 10-in. line and was authorized by the trustees to proceed with the project. As the result, a motor-driven single-stage centrifugal pump (6-in. suction and discharge), of pressure type, was bought, having a rated capacity of 765 gal. per min., and raising the head 55 ft. It was direct connected to a 20-hp. 60-cycle motor to run at 1200 r.p.m.

A gate valve had been placed at the low point of the supply line, as shown in the accompanying sketch, when the pipe was laid. This point was selected for the installation of the booster and the line was tapped above this valve for the intake and below for the outlet, the old line serving as a bypass around the pump. Before the pump was shipped, foundations were put in, a house was built, and everything made ready for slipping the unit into service at the earliest possible moment. Indeed, in 14 hours after the machine arrived, it was running.

The reason for this haste lay in the difficulties which had been brought by extreme cold weather. Before the pump arrived, all the consumers were letting their outlets run to keep the water from freezing. Added to this, the railroad supplies on each side of town froze up, so that the locomotives all watered from the Malone supply and this used up, in short order, what little remained in the reservoir.

When pumping was started, the reservoir was empty. The water department was helped in filling the basin by a couple of days of milder weather. The reservoir (holding 1,500,000 gal.) was full in 98 hours. No tests are reported as to the ultimate capacity of the system as now equipped. Probably the capacity has been increased some 40%. There has been no trouble in keeping the reservoir filled since pumping was started. The procedure in starting and stopping is ordinary, the gate valve in the 10-in. line is shut and the motor thrown into service, when the gages show a pressure difference of 25 to 30 lb. per sq.in. between the intake and discharge.

The whole installation, including buildings, foundation piers, pumps, motors and fittings, cost about $1000. The bill for electricity will run about $1000 or less per year, depending on weather conditions.

⁂

A Concrete Block Lining for a Circular Shaft was successfully employed recently at a colliery near Charleroi, Belgium. The depth of the shaft was 130 ft. The excavation was 16½ ft. in diameter to allow a clear finished diameter of 13 ft. The blocks, made on the spot in wooden molds, were 30 in. in height and of a minimum thickness of 3⅛ in., their length being one-fourteenth of the circumference of the shaft. Each block was shaped to fit the curve of the shaft. Netting of ⅛-in. wire was imbedded in the block. To give mutual support to the blocks, two ½-in. iron rods 1 ft. in length penetrated 6 in. into the mass of the block on its upper edge, and two corresponding holes were made in its lower edge. Into these penetrated the projections of the rods in the block beneath when placed in position, so as to interlock them. Besides these rods, four rings, two near the top and two near the bottom on the extrados side, were imbedded in the block. Through each of these a ½-in. iron rod, bent into the form of a V, was passed and attached to ½-inch vertical rods 1 ft. in length in the space behind the ring of blocks. This space was filled with concrete burying these reinforcing rods, which then served to retain the blocks in position. The cost amounted to $9 per lin.ft. From tests made, it was estimated that the resistance of this lining was equal to a 31½-in. brick lining, the cost of which would be nearly twice as great.

⁂

Building Statistics in the Borough of Manhattan, New York City, as given in the annual report for 1912, just issued, show that the skyscraper is not as an important feature of the city's buildings as the view from the lower bay would indicate. It is interesting to note that nine-tenths of the existing buildings are not more than six stories high and that only a little over 1% are over 10 stories. The figures are as follows:

Height		No.	%
6 stories or less		83,056	89.55
7-10 stories		8,645	9.32
11-13 stories		822	0.89
14-20 stories	175		
21-30 stories	42		
31-40 stories	6		
41-50 stories	2		
Over 50 stories	1		
		226	0.24
		92,749	100.00

The proportion of fireproof buildings is as follows:

		No.	%
Frame buildings		6,963	7.51
Ordinary construction		83,544	89.00
Semi-fireproof	286		
Fireproof	2956		
		3,242	3.49
		92,749	100.00

The December Floods in Texas

By B. Bunnemeyer*

SYNOPSIS—In record-breaking floods in Texas in December, 1913, 177 persons lost their lives and property was destroyed valued at over $8,000,000. The floods were caused by a phenomenally heavy rainfall upon ground already water-soaked.

The floods that occurred in Texas during the last month of the year 1913 exceeded all previous records there, not only as to depth of water recorded but also as to extent of territory covered. Four of the streams on which river stations are maintained, viz., the Guadalupe, Colorado, Brazos and Trinity, and many of their tributaries, draining more than half the area of Texas, were out of banks simultaneously. The flooded area probably

Fig. 1. Map of Texas, Showing Flooded Rivers

exceeds 3000 sq.mi. The floods began during the opening days of December coincident with heavy rains. The rivers above noted attained a width of from 5 to 30 miles in some sections. The flood district is shown in Fig. 1.

The crest of the Guadalupe flood passed Gonzales on Dec. 4, and Victoria on Dec. 7, with river stages higher than ever recorded before. The Colorado flood was at its highest at Austin on the night of Dec. 4, and the crest reached Columbus on Dec. 6. At the latter place, it exceeded all previous records; but at Austin the waters were not so high as they were on Apr. 7, 1900, when the great dam broke. The Brazos flood gave record stages at all points from Waco to the Gulf. The crest of the flood was at Waco on Dec. 3; at Hempstead on the 8th; and at Booth on the 10th. The Trinity flood established no new records. The crest was at Dallas on Dec. 6; reached Long Lake (near Palestine) on the 9th; Riverside on the 18th; and Liberty on the 26th.

The streams rose suddenly in the upper portions of the flooded area and almost as fast as the rains fell. In the lower portions the flood waters moved slowly and covered larger areas because the land is more or less level. The rainfall also was much less along the coast than in the interior.

Warnings—Advisory warnings of sharp rises were issued from the local office of the Weather Bureau, at Houston, Tex., on Dec. 2, to points along the Guadalupe, Colorado, Brazos and Trinity Rivers, and these advices were followed up with flood warnings on Dec. 3 and 4, to the effect that "unprecedented floods were anticipated and that all possible precautions should be taken." Further advices were issued daily keeping threatened points informed of the progress of the flood.

Information was given out daily by long-distance telephone (in some cases the only means of communication left), and nightly until after midnight. The warnings were generally heeded; stock was driven from the lowlands, property moved to higher places, boats were constructed to meet emergencies and other precautionary measures were taken; but there were thousands who doubted and hesitated. The *Texas Coaster*, of Richmond, Texas, of Dec. 12, 1913, contained the following statement which applies to nearly all sections of the stricken area:

> Wednesday (Dec. 10) the flood waters of the Brazos reached the high mark at Richmond and for several hours held higher by a foot or more than the record flood of 1899. * * *
>
> While the loss will not reach the magnitude of the 1899 flood by hundreds of thousands, it will still be enormous and make untold hardships for many thousand families. * * *
>
> One lesson has been thoroughly taught dwellers in the bottoms. Perhaps two. The first is that they must not ignore the reports of the U. S. Weather Bureau; and when the river makes a record rise at a point from three to five days above us to heed the warning and cease to believe and hope that God Almighty will in some way stop the waters on their way to the sea and prevent them from reaching lower points. The other lesson, if it be one, is that in a safe retreat there is less danger than to stand your ground until you are surrounded by water. It is better to prepare for a big flood and move everything out and then no flood come, than to stay and perhaps be deceived.

Deaths—Notwithstanding timely and repeated warnings, reports of deaths came in daily. It should be noted, however, that most of the deaths occurred among negroes, and among Mexicans and other foreigners, who either did not heed the warnings or resided in too remote places to be warned, and were surrounded by water before they realized their danger, seeking refuge in trees and on tops of houses and other projections. The death list is large, but may never be known definitely as some families living in isolated localities were wiped out. I have taken careful account of all deaths reported, entering the names in alphabetical order so as to avoid duplication, and find that 105 persons perished whose names were given, and that 72 unknown persons were drowned—making a total of 177 deaths.

Relief Work—Relief and rescue parties were organized early and heroic work was done in saving those marooned. Several of the rescuers sacrificed their lives in saving others. The suffering from exposure and hunger was great. From Dec. 5 to 7, the night temperatures ranged from 45 to 55° F., and on the 8th and 9th from 32 to 37°, which increased the sufferings of the shelterless. Local rains set in on Dec. 11, and became more or less general on the 13th, adding to the uneasiness in the flooded district.

Throughout the flooded area entire towns were isolated and parties marooned without shelter and frequently without food. Instances were reported where some people subsisted on raw meat from animals fished out of

*Section Director, Weather Bureau, Houston, Tex.

the water. Splendid work was done by the relief committees; and citizens in many towns responded liberally to appeals with money, clothing, food and other necessities. Boats were sent from Houston, Galveston, Beaumont, Velasco and other points to the stricken area, and the life saving crew from Galveston and the revenue cutter "Windom" aided in rescue and relief work. Tents and rations were furnished by the War Department. Much sickness followed the great overflow of 1899, and the health officers took early action to prevent a repetition..

Damage—The damage wrought by the flood waters was appalling and would have been still greater if the floods had occurred before the gathering of the crops. As it was, the crop loss was great.

Residences and barns were lifted from their foundations, and floated off with the current; and thousands of people became homeless. Stock and other animals were drowned in large numbers. Numerous bridges were washed away; railroad and mail services were entirely suspended and the business generally was paralyzed. As an extreme instance, I may mention Stone City in Brazos County, which received no mail from Dec. 4, 1913, to Jan. 9, 1914.

So far as I have been able to gather statistics (which are incomplete) the losses reported in the valleys of the several flooded rivers, are as follows: Guadalupe, $761,000; Colorado, $1,446,300; Brazos, $3,436,155; Trinity, $238,800; San Antonio, $100,000; for three railroads and one telephone company, $2,559,500; total, $8,541,755.

The saving effected through warnings was great, but was reduced to figures in only a few instances, as follows: Guadalupe Valley, $250,000; Colorado Valley, $27,500; Brazos Valley, $1,000,000; total, $1,277,500.

In the majority of cases upon receipt of the warnings, the stock was driven to higher places and other property moved, but the value was omitted so that no reliable estimate can be given.

Causes of the Floods

While the rains of Dec. 1-6 were unusually heavy and in some cases torrential in nature, they would not have resulted in such unprecedented floods, had they been preceded by a spell of fair weather; but the ground was thoroughly saturated by heavy rains during the last 10 days of November; and the runoff therefore was at its maximum in speed as well as in amount. These rains swelled the streams to abnormal heights, with freshets in the Colorado River at Columbus, and in the Guadalupe at Victoria—conditions which decidedly aggravated the subsequent floods.

Another aggravating factor was the breaking in many sections of levees. Many were thus caught unawares. The total rainfall during the last 10 days of November averaged 4.21 in. for the Guadalupe Valley; 3.74, Colorado; 3.53, Brazos; 2.98, Trinity; and 4.05, San Antonio. These rains laid the foundation for the greatest floods of which there is authentic record; they themselves would have caused serious floods if they had fallen within a day or two instead of extending over a period of 10 days.

The rains during the first few days of December, which were the immediate precursor of the floods, were more or less continuous, but were heaviest on Dec. 2, 3 and 4. The total rainfall averaged 4.78 in. for the Guadalupe watershed; 3.95, Colorado; 5.37, Brazos; 5.30, Trinity; and 2.94 for the San Antonio. About 85% of the amounts were reported on Dec. 2, 3 and 4. The heaviest amounts in the Colorado watershed were reported on the 2nd; in the Brazos and San Antonio on the 3rd; and in the Trinity and Guadalupe on the 4th.

Weather Conditions—The cause of these excessive rains is not far to seek. The weather maps of Dec. 1-4 showed an area of low barometric pressure hovering over the Southwest, which was attended by unusually warm weather in Texas. The abnormal warmth naturally induced strong ascending currents which, expanding aloft and cooling to below the dewpoint, resulted in copious precipitation. The ascending currents were replaced by warm, moisture-laden air from the Gulf of Mexico, which served as feeder and kept up the process of condensation. As the area of low pressure changed but little from day to day, condensation continued until the depression began to move eastward on Dec. 5. On that day clearing and colder weather set in; the 6th was clear and cool.

Effect of Precipitation—In studying the effect of precipitation upon the flow of rivers, probably the two most important factors to be considered are evaporation and condition of soil. This is evidenced from the fact that the floods of December, 1913, while exceeding any previous floods on record, were caused by less precipitation than were some of the former floods. For instance, the flood of the Brazos in 1899 was caused by copious rains during the last five days of June of that year, which averaged heavier than those that caused the recent flood.

Among the heavier total amounts (in inches) reported for these five days were: Waco, 7.30; Hewitt, 14.95; Temple, 9.62;Brenham, 20.08; Sugarland, 12.30; Columbia, 9.17; and Brazoria, 8.68. The redeeming features were a more active evaporation and a period of 10 fair days preceding the precipitation. The total rainfall for the state for June, 1899, averaged 7.07 in. against 5.03 in. for December, 1913.

The big flood of the Guadalupe of October, 1913, was also caused by heavier rains than the bigger flood of December, 1913. The October flood gave high-water marks to date and caused more damage than the recent flood because the crops had not been gathered. The average rainfall in the Guadalupe Valley for the four days causing the October flood was 6.76 in. against only 4.78 in. for the four days in December.

Other instances could be cited of heavier rains with less severe floods. In glancing over the state records and without going into details, the records show that there were numerous months in which the precipitation for Texas was much greater than it was in December, 1913; in fact, it was greater in all months, except March. Since 1888, it was greater once in February and October; twice in January, August and November; 3 times in May, July and September; 4 times in April; and 5 times in June.

These statistics are of interest in showing not only the frequency of excessively wet months, but also the probability of floods, whose severity naturally depends in a large measure upon the combinations favorable for a large runoff. Floods of more or less extent have occurred in Texas since records were kept, in all months of the year except in January. They are more frequent in April, May and June than in any other season of the year.

Flood of the Guadalupe

The Guadalupe, which rises in Kerr County and flows southeastward into San Antonio Bay, has a length of 289 miles and drains an area of 5568 sq.mi. Its largest tributary is the San Marcos River and it is regarded as the best water-power stream in the state.

The floodwaters of the Guadalupe came principally from the San Marcos River which empties into the Guadalupe a short distance above Gonzales, where a river gage is maintained. At 6 p.m., Dec. 2, the river gage at this point read 8.2 ft., and the river was just beginning to rise. Advisory warnings had been sent out in the fore-

Fig. 2. Guadalupe Flood at Gonzales
(View after river had fallen 3½ ft. Electric power plant in foreground.)

noon. The stream rose rapidly and by 3 p.m., on Dec. 3, reached a stage of 21 ft., which is one foot below flood stage. Warnings were again issued on this day. The next morning, Dec. 4, a stage of 25 ft. was reported and the stream was then rising at the rate of 1.1 ft. per hour. At the same time San Marcos reported a rainfall of 10 in. and no doubt was left that new high-water marks would be established. So swift were the waters from this rain that the full effect of the downpour was felt at Gonzales by 7 p.m. on Dec. 4, when the gage read 38.1 ft., which marked the crest of the flood. This is the highest stage on record and was 1.4 ft. higher than the flood of October, 1913, which was the high-water mark until then. From this time on, the water receded at an average rate of about 3 ft. per day; and on Dec. 9, was within banks.

At Gonzales, the flooded area attained a width of from 2 to 5 miles. In the immediate vicinity of Victoria, the width of the flood was about 3 miles; two persons were drowned in that section. The greatest damage appears to have occurred in Dewitt County; and at Cuero, H. R. Frobese reports the flooded area in his county as 30 miles long by about 1½ miles wide, with depths of water ranging from 4 to 20 ft. Cuero is about midway between Gonzales and Victoria. Flood conditions in this section are shown in Figs. 2 and 3.

Flood of the Colorado

The Colorado rises in western Texas near the eastern boundary of New Mexico. It has a length of 605 miles and drains an area of 45,400 sq.mi.

At Marble Falls, the river rose from 9.3 ft. on the 1st to 21 ft. on the 3rd and began falling on the same day. There was no overflow at Marble Falls, although a formidable volume of water went over the natural dam at that point. This 21-ft. stage was telephoned to points below and caused much alarm as it was interpreted as a 21-ft. high wall of water rushing over the dam. It probably had a salutary effect. The banks of the river at Marble Falls are very high and so far as known have not been topped by water.

At Austin, 83 miles below Marble Falls, the river gage read 10.3 ft. at 7 a.m. on Dec. 2, and registered 25 ft. by 4:40 p.m., the rise averaging 1.5 ft. per hour. Later in the day there was a temporary, but marked fall, and on Dec. 3, the river began to rise again and by 7 a.m. Dec. 4, was again at 25 ft.

This is the highest measurement secured but the waters rose still higher during the night as evidenced by the fact that the water went over the South Austin dike, which it had not done when the stage was 25 ft. It is estimated that the highest stage reached was 27 ft. at

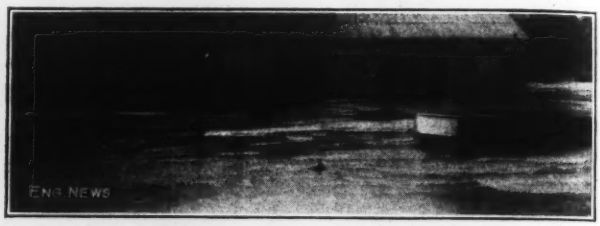


Fig. 3. The Electric Power Plant at Cuerpo Flooded by the Guadalupe

1 a.m. on Dec. 5. At the new unfinished dam which will replace the dam broken in the big flood of April, 1900, the highest water was within 1½ ft. of the top of the structure. The dam stood the strain, but the coffer-dams were reported washed away. At the Congress Ave. bridge, where the river gage is located, the river during the highest stage was ½ mile wide. Many buildings, including the basements of some of those of the State University, were flooded. The highest stage of record at Austin is 34.7 ft. and occurred Apr. 7, 1900, when the dam broke.

At Bastrop, below Austin, the stream began to rise rapidly on Dec. 2 and the crest was reached on the 5th, when the town was from 2 to 3 ft. under water. From press reports, it appears that the water was 7 ft. lower than in 1869. At Hills Prairie, several miles below Bas-

Fig. 4. Showing Depth of Colorado River Flood at Columbus

trop, the flooded area had a width of 4 to 5 miles. At La Grange, the levees were swept away and the town was in darkness during the night. The water was 1 ft. higher than in 1869, the year of the greatest flood.

At Columbus, 116 miles below Austin, the river at 7 a.m., on Dec. 6, reached a stage of 44.1 ft., which establishes a new high-water mark. The previous high-

water mark was 41.2 ft., which occurred during the flood of 1869. The town was submerged and completely surrounded by water (see Fig. 4.) At the deport the water stood 18 in. deep, and railroad tracks were under 5 ft. of water from mile post 78 to Alleyton.

The higher parts of Alleyton were reported under 4 ft. of water.

As the flood waters moved south into the more level coast counties they submerged larger areas. Wharton was surrounded by water and partly submerged. The flood spread east a distance of several miles, and west a distance of eight miles (as far as Pierce), on Dec. 6. Bay City kept a force of 100 to 300 men, day and night, strengthening the levees protecting the town on the north and west.

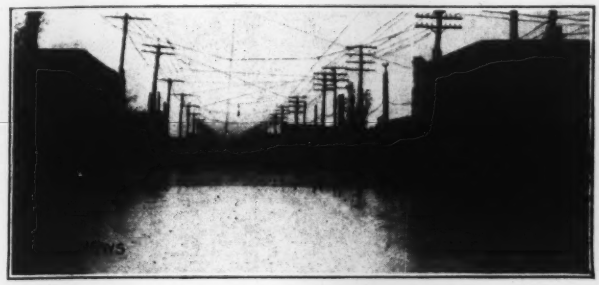


FIG. 5. ELM STREET IN WACO, FLOODED BY THE BRAZOS

Comparatively little water came down from north of Waco.

At Waco, the stream began to rise on Dec. 1, the gage at 7 a.m. of that date reading 13 ft., and continued to rise at a phenomenally rapid rate until 6 p.m. of the 3rd when a stage of 39.7 ft. was reached, which is the highest of record. The former high-water mark at Waco was 36.7 ft., on May 25, 1908. At 2:30 a.m., on Dec. 3, the waters broke over the levee at the pumping station, ½ mile above the city, rushing rapidly into the lowlands and flooding the eastern section of Waco. Fifteen city blocks were under water at flood height; several persons were drowned; 1200 people rendered homeless; and damage probably exceeding $1,000,000 resulted. After 6

FIG. 6. WEIGHTED BRIDGE OF THE MISSOURI, KANSAS & TEXAS RY., AT WACO

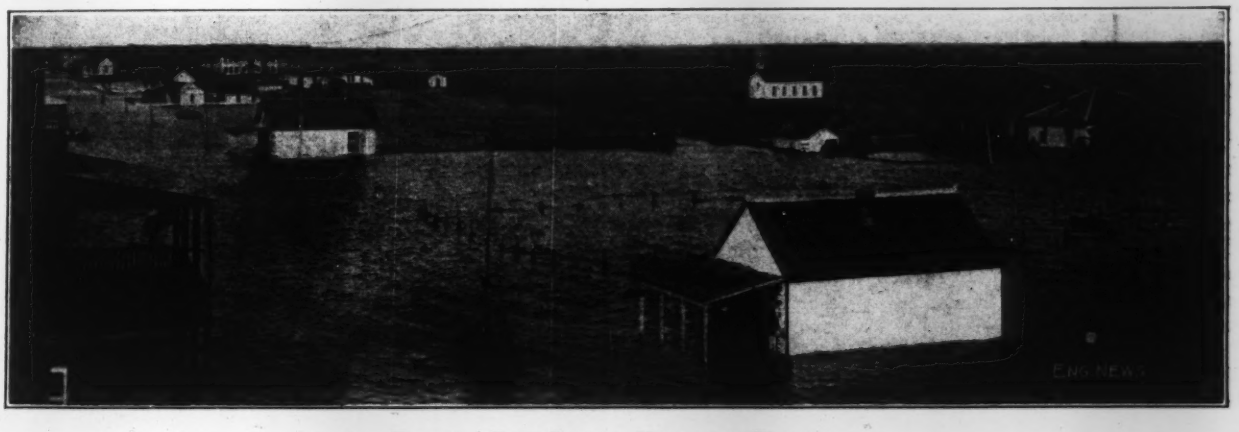


FIG. 7. THE BRAZOS FLOOD AT VELASCO

The damage reported from this flood so far is as follows:

Loss to buildings, municipal plants, bridges, etc., but not railroad or trolley lines	$193,000
Crops which may or may not have been housed	213,500
Crops still in the field	178,500
Live stock and other movable property	195,500
Loss due to suspension of business, including wages of employees	9,100
Losses unclassified	656,700
Total	$1,446,300
Money value of property saved by warnings	$27,500

FLOOD OF THE BRAZOS

The Brazos River rises in the staked plains of western Texas. It has a length of 950 miles and drains an area of 36,763 sq.mi.

The flood of the Brazos covered the entire valley from Bosque County to the coast, including the three principal tributaries and all creeks joining the main stream below that county (see Figs. 5, 6 and 7).

p.m. of the 3rd, the waters began to recede, slowly at first and then more rapidly, and by 7 a.m., on Dec. 8, the water was within banks.

Valley Junction, which is just below the confluence of the Brazos and Little Rivers and therefore received the combined flood waters of these streams, is a small settlement, but an important railroad crossing. The last reading there, before the flood, was 33.8 ft., at 7 a.m., on Dec. 3, and readings were begun again at 7 a.m., on Dec. 12, when the river gage read 21.5 ft.

The junction of the two streams formed an immense sea, and it was here that H. Martin, Vice-President of the International & Great Northern Ry., who had taken personal charge of affairs, was drowned, and several other persons perished. The flood waters began to cover Valley Junction about 4 a.m., Dec. 4, and to subside on the morning of Dec. 7. The highest stage is estimated at 55

TABLES A. RAINFALL ON THE SEVERAL WATERSHEDS BEFORE AND DURING THE FLOODS

1. GUADALUPE WATERSHED

Stations	last 10 days of Nov.	Rainfall in inches Dec. 1	2	3	4	5	6	Total
Kerrville	4.42		0.66	2.67	1.12	0.60		5.05
New Braunfels	5.98	0.20	0.37	0.73	4.20	0.94		6.44
Luling	5.02		1.05	0.69	2.05	1.00		4.79
Blanco	3.62	0.04	1.25	0.65	4.12	0.65		6.71
San Marcos	4.51		2.00	2.45	10.00	1.05		15.50
Flatonia	2.65	0.07	0.36	0.99	0.40	0.43		2.25
Gonzales	3.73		0.30	1.90	1.05	0.20		3.45
Cuero	5.89		0.74	1.00	0.11	0.25		2.10
Victoria	3.50			0.40	0.35	0.45		1.20
Tivoli	2.75			0.17		0.15		0.32
Total	42.07	0.31	6.73	11.65	23.40	5.72	0.00	47.81
Average	4.21	0.03	0.67	1.16	2.34	0.57	0.00	4.78

2. COLORADO

Lamesa	2.49		0.08	0.12				0.20
Gail	2.50		0.40	0.50	0.30			1.20
Midland	3.82							
Garden City	2.34		1.52	0.56	0.06			2.14
Snyder	2.49		1.02	0.17	1.06	0.12		2.37
Big Spring	1.40		1.08	0.97	0.11			2.16
Colorado	2.75		2.35	0.92	0.80			4.07
San Angelo	4.84	0.15		0.69	0.51			1.35
Knickerbocker	3.50	0.03	0.45	0.87	0.75	T		2.10
Ballinger	7.05		0.25	0.10	1.55	0.60		2.50
Winters	5.00	T.	T.	0.40	0.76			1.16
Coleman	7.60	0.25	0.12	1.29	0.57			2.23
Santa Anna		1.80	2.17		1.60	0.10		5.67
Brownwood	5.32		1.05	1.10	0.35	0.45		2.95
San Saba	4.17	0.05	0.97	0.44	0.68	0.61		2.75
Junction	5.50		3.00		0.58			3.58
Llano	2.75		1.68	0.73	1.93	0.34	T.	4.68
Marble Falls	1.70		5.66	2.00	2.50	0.65		10.75
Harper	3.36	1.71	0.30	1.50	0.27		0.09	3.87
Fredericksburg	3.67	1.06	2.22	1.42	1.70	0.25		6.65
Duval	2.56	0.09	2.21	4.50	2.78	2.07		11.65
Austin	1.86	0.06	1.85	6.34	4.32	1.50		14.07
Lagrange	2.68	0.02	0.56	1.62	1.44	1.00*	1.00*	5.64
Columbus	5.25		0.25	0.70	0.90	1.25		3.10
Bay City	3.79		T.		0.51	0.26		0.77
Pierce	5.15		0.15		0.16	0.67	0.14	1.12
Total	93.54	5.22	29.28	26.94	26.19	9.87	1.23	98.73
Average	3.74	0.21	1.17	1.08	1.05	0.39	0.05	3.95

* Estimated.

ft., and was fully 4 ft. higher than in the record flood of 1899.

The depth of the water in the lowlands ranged from 3 to 25 ft. Near Bryan, which is about 14 miles below Valley Junction, the great levee, having a length of 27 miles and protecting 55,000 acres, crumbled before the rushing waters which, rapidly filling the lowlands, formed a lake 5 miles wide. At about 3 p.m., on Dec. 4, the water began running over the levee and the next morning only a few places could be seen barely projecting above the water and affording a temporary refuge for animals caught by the flood. Many other levees failed to hold, but this was the largest.

At Chapell Hill, which is several miles west from the Brazos, between the river and Brenham, the flooded area ranged from 3 to 7 miles in width, and the depth exceeded the 1899 flood by 3.5 ft.

Hempstead, where a river station is maintained, is 75 miles below Valley Junction and opposite Chapell Hill on the east side of the river. The highest reading recorded on the Weather Bureau gage was 52.8 ft. at 7 a.m., on Dec. 9. The crest of the flood appears to have passed, however, on Dec. 8, as shown by the gage on the Houston & Texas Central R.R. crossing, a mile or two above our river gage. This gage showed a height of 55.6 ft. on the 8th, which is said to have been the highest during this flood.

The width of the flooded area at Hempstead was from 6 to 8 miles.

As the flood waters approached the Gulf of Mexico over the flat coast section, they spread out over a correspondingly larger area. East of the Brazos, they extended in some sections for a distance of 30 miles, and on the west side are reported to have joined the flood waters of the Colorado. This has not been verified. It is certain, however, that all the streams between the Brazos and the Colorado, the largest of which is the San Bernard, were higher than ever known before.

3. BRAZOS WATERSHED

Plainview	....	0.02	0.07	0.24	0.76			
Mount Blanco	2.86			0.15		0.40		
Lubbock	0.85	0.04	0.04	0.18	0.43		T.	
Tahoka	1.24	0.03	0.10	0.22	0.08			
Post	1.60	T.	0.33	0.34	0.20	0.10	0.03	
Spur	1.66		0.78	0.33	0.34	0.10		
Jayton	1.60		1.60	1.10		0.80		
Aspermont	2.45		0.88	0.81	0.50			
Haskell	3.08		1.28	0.12	0.32	0.58		
Goree	2.77	1.49	0.20	0.94	0.76			
Seymour	1.86		0.65	0.30	0.70	0.50		
Claytonville	2.64	T.	1.20	0.62	0.73	T.		
Abilene	4.33	0.01	0.05	0.49	0.83			
Hamlin	3.90		0.75	0.75	0.85			
Stamford	4.34		1.21	0.68	0.63			
Albany	5.37	0.26	0.25	0.30	0.85	0.13		
Graham	4.02	0.51	0.28	0.11	1.49	0.15		
Putnam	5.00	0.30	1.30	0.32	1.55			
Brazos	4.71		0.30	4.21	1.00	0.67		
Eastland	4.87		0.30	0.55	0.65	0.30		
Comanche	6.10	0.10	1.00		1.28	0.35		
Panter	5.43	0.03	1.45	1.00	1.29			
Thurber	4.98	0.03	0.90	1.00	0.54	0.12		
Dublin	5.31		0.11	0.81	1.08	0.61		
Cleburne	3.85		4.02	0.71	1.07			
Hico	4.82	2.15	1.39	0.61	1.44	1.44		
Kopperl	3.60		1.70	2.50	1.64	1.74		
Clifton	4.88	0.04	4.51	3.38	0.82	0.70		
Hillsboro	1.80	1.65	4.52	2.37	1.46			
Lampasas	3.09		6.05	1.57	1.67	1.03		
Gatesville	3.50		3.60	2.40	0.90	0.65		
McGregor	2.85		4.45	5.50	1.10	0.65		
Waco	3.52		1.42	2.00	5.40	1.00		
Hewitt	2.72	T.	2.22	7.86	0.80	0.96		
Gorham	4.07	2.25	4.70	3.37	0.90			
Mexia	1.97	0.10	4.35	2.76	1.43	0.06		
Salado	2.30		2.67	5.90	1.50	1.15		
Temple	2.63		1.00	4.43	2.93	1.40	0.03	
Taylor	2.28	0.05	2.25	5.60	1.83	0.30		
Georgetown	3.24		4.00	4.51	5.05	0.02		
Cameron	2.67	0.62	4.09	4.29	0.97			
Valley Junction	1.53		0.30	0.65	*	*	*	
College Station	3.39		0.20	1.39	7.54	0.75	T.	
Bryan	3.43	0.28	0.10	6.50	0.78			
Somerville	11.00		0.30	5.00	7.75	0.50		
Brenham	8.40		0.16	0.42	3.73	0.50	0.05	
Hempstead	3.63	T.	T.	0.50	2.70	0.70	T.	
Sealy	2.75		0.14	0.11	0.99	0.28		
Sugarland	1.10	*	*	*	*	*		
Booth	3.42		0.10	0.15	1.20	0.05		
Brazoria	3.30	T.			0.27	0.22		
Total	176.71	9.96	73.27	90.05	72.73	18.91	0.11	268.68
Average	3.53	0.20	1.47	1.80	1.48	0.39	T.	5.37

*Daily record not kept.

4. TRINITY WATERSHED

Bowie	4.10		0.51	1.02	0.65	0.76		2.94
Antelope	3.68	0.78	0.27	T.	1.16			2.21
Gainesville	5.99	0.03	1.80	0.81	0.30	0.53		3.47
Bridgeport	4.03			1.20	0.66	0.56		2.42
Weatherford	3.96		0.30	1.25	0.69	0.65		2.89
Grapevine	5.09		3.67		0.52	1.00		5.19
Fort Worth	4.68	0.01	2.53	0.51	1.16	0.02		4.23
Denton	3.58		1.69	0.10	0.47	0.63		2.89
McKinney	3.13	T.	2.60	0.25	0.80	0.86		4.51
Dallas	2.71	T.	3.83	0.54	1.05	0.11		5.53
Kaufman	0.79		1.90	7.53	0.73	1.57		11.73
Waxahachie	1.40		1.85	3.40	1.55	1.40		8.20
Corsicana	2.19		0.93	3.77	3.25	1.05	0.17	9.17
Palestine	0.85	T.	0.29	5.13	1.55	0.98		7.95
Long Lake	1.60			2.20	4.50	1.60	0.20	8.50
Jewett	1.90			1.50	4.50	1.25		7.25
Crockett	2.10		0.02	1.18	2.62	0.97		4.79
Riverside	1.85				3.50	1.80		5.30
Huntsville	1.93				4.40	1.90	T.	6.30
Liberty	4.00			T.		0.23	0.23	0.46
Total	59.56	0.82	22.19	30.39	34.06	17.87	0.60	105.93
Average	2.98	0.04	1.11	1.52	1.70	0.89	0.03	5.30

5. SAN ANTONIO

Boerne	5.61	1.10	0.63	2.20	0.78			4.71
San Antonio	3.93	0.13	0.11	0.40	2.02	0.83		3.49
Sutherland Spgs.	3.47			3.40	0.60			4.00
Runge	2.45		0.43	0.78		0.56		1.77
Goliad	4.80		0.20	0.18	0.21	0.16		0.75
Total	20.26	1.23	1.37	6.96	3.61	1.55	0.00	14.72
Average	4.05	0.25	0.27	1.39	0.72	0.31	0.00	2.94

The damage reported from this flood so far is as follows:

Loss to buildings, municipal plants, bridges, etc., but not railroad or trolley lines	$841,050
Crops which may or may not have been housed	924,455
Crops still in the field	120,200
Live stock and other movable property	442,200
Loss due to suspension of business, including wages of employees	28,600
Unclassified	1,079,650
Total	$3,436,155
Money value of property saved by warnings	$1,000,000

Flood of the Trinity

The Trinity rises in a network of small streams in the

TABLES B. RIVER STAGES DURING TEXAS FLOODS

Boldface type indicates river was at or above the flood stage

1. GUADALUPE

7 a. m. on Dec.	Gonzales	Victoria
	Flood stages	
	22 ft.	16 ft.
1	12.7	**21.0**
2	7.8	**20.8**
3	15.0	**20.0**
4	**25.0***	**20.5**
5	**35.6**	**22.0**
6	**33.0**	**23.3**
7	**30.8**	**24.7†**
8	**27.0**	**24.4**
9	**23.0**	**24.2**
10	**19.0**	**23.8**
11	**15.2**	**23.4**
12	**14.3**	**23.0**
13	**11.8**	**22.6**
14	**10.5**	**22.0**
15	**10.0**	**19.4**
16	**9.1**	**16.9**
17	**9.5**	**15.6**
18	**11.0**	**15.7**
19	**9.8**	**16.6**
20	**8.3**	**17.3**

* Crest 38.1 ft. at 7 p. m. † Crest 24.8 ft. at 11 p. m.

2. COLORADO

7 a. m. on Dec.	Ballinger	Marble Falls	Austin	Columbus
	Flood stages			
	21 ft.	36 ft.	18 ft.	24 ft.
1	11.0	9.3	9.5	**34.8**
2	7.0	16.3	10.3‡	**33.6**
3	10.0	21.0	16.5	**31.6**
4	13.0	16.0	**25.0**	**34.6**
5	16.5*	13.0	**20.7†**	**38.8**
6	13.0	12.5	14.5	**44.1**
7	5.0	12.6	13.5	**42.2**
8	2.0	12.5	13.4	**39.6**
9	1.6	11.0	13.0	**37.6**
10	1.4	6.0	9.0	**36.2**
11	1.2	5.3	6.4	**35.2**
12	1.0	5.0	5.4	**31.6**
13	1.0	4.5	5.3	22.7

* Crest 17.6 ft. †Crest 27 ft. at 1 a. m. ‡ Crest first rise 25 ft. 4:40 p. m.

3. BRAZOS

7 a. m. on Dec.	Brazos	Kopperl	Waco	Valley J.	Hempstead	Booth
	Flood stages					
	12 ft.	21 ft	22 ft.	40 ft.	40 ft.	39 ft.
1	9.0	8.2	13.0	16.0	26.2	28.9
2	7.0	8.0	**21.9**	26.0	28.6	29.9
3	10.0	15.0	**33.1†**	33.8	29.0	29.8
4	**12.0***	19.6	**37.0**	‡	37.0	30.6
5	11.0	**22.4**	**32.7**		**40.9**	34.6
6	11.0	16.0	**29.0**		**42.6**	38.4
7	8.0	14.6	**23.5**		**52.0**	**40.7**
8	6.5	11.4	19.1		**52.6**	**42.2**
9	6.5	10.8	14.7		**52.8**	**44.0**
10	6.0	8.2	13.3		**49.8**	**47.5**
11	5.5	6.4	12.7		**46.2**	**47.2**
12	4.5	5.8	11.4	21.5	**44.2**	**46.1**
13	4.0	5.0	9.4	19.0	**41.0**	**45.5**
14	3.5	4.0	9.2	17.4	**40.8**	**44.9**
15	3.2	3.2	8.2	14.0	39.6	**44.5**
16	3.0	3.0	7.7	13.5	37.0	**44.0**
17	4.0	3.0	9.7	13.0	34.4	**43.4**
18	3.8	3.0	8.3	13.0	30.2	**43.3**
19	3.4	2.8	7.5	12.5	26.2	**43.1**
20	3.0	2.8	7.3	12.0	20.0	**42.5**
21	2.8	2.8	7.3	11.8	16.0	**39.7**
22	2.7	2.4	7.0	11.5	15.1	33.7

*Crest 13.5 ft. at 6 p. m. † Crest 39.7 ft. at 6 p. m.
‡ No gauge reading taken Dec. 4-11. River 5 miles wide, and crest estimated to be 15 ft. above flood stage.

4. TRINITY

7 a.m. on Dec.	Bridgeport	Dallas	Long Lake	Riverside	Liberty
	Flood stages				
	20 ft.	25 ft.	40 ft.	40 ft.	25 ft.
1	5.8	**28.6**	21.6	12.0	6.0
2	12.2	**29.1**	22.4	12.0	9.0
3	**20.9***	**32.5**	24.0	12.0	13.0
4	**21.2**	**36.9**	30.9	25.0	13.6
5	13.2	**36.5**	35.0	35.6	15.0
6	9.6	**38.2†**	36.0	38.5	19.0
7	5.4	**37.1**	**45.3**	38.2	22.5
8	4.8	**34.9**	**48.6**	36.8	23.6
9	4.2	**32.8**	**49.5**	35.0	24.2
10	4.2	**30.5**	**47.3**	32.0	**25.0**
11	4.0	**29.0**	**46.4**	30.8	**25.5**
12	4.0	**26.2**	**44.0**	30.7	**25.8**
13	3.8	21.1	**43.8**	32.7	**26.3**
14	3.6	13.8	**42.3**	37.5	**26.5**
15	3.4	15.0	**42.0**	**40.1**	**26.5**
16	3.2	14.6	**42.5**	**44.8**	**26.5**
17	3.0	13.5	**41.0**	**46.5**	**26.6**
18	3.0	18.1	**40.0**	**47.0**	**26.6**
19	2.8	17.2	**40.0**	**46.9**	**26.7**
20	2.6	14.2	**40.2**	**46.4**	**26.8**
21	2.2	13.2	**40.0**	**45.5**	**26.9**
22	2.2	13.0	39.3	**44.5**	**27.1**
23	2.0	12.5	38.0	**43.5**	**27.3**
24	2.0	14.5	37.0	**42.8**	**27.5**
25	2.0	13.3	35.6	**41.5**	**27.6**
26	1.8	11.8	34.0	**40.5**	**27.9**
27	1.6	10.3	33.0	**39.5**	**27.9**
28	1.6	9.9	30.0	**39.0**	**27.9**
29	1.5	9.4	27.6	**38.5**	**27.8**
30	1.4	8.7	25.4	**37.5**	**27.6**
31	1.4	8.5	23.5	**36.0**	**27.4**

* Crest 21.7 ft. at 2.30 p.m. † Crest 38.4 ft. at 9.20 a.m.

north-central portions of the state and flows nearly parallel to the Brazos into Galveston Bay. It has a length of 408 miles and drains an area of 17,700 sq.mi. Below Dallas, the stream flows through a wooded country which retards the runoff. Logging operations are carried on for a distance of about 100 miles from its mouth.

The flood of the Trinity began on Dec. 1, 1913, at Dallas. The city had just passed through a freshet in November, and on the last day of that month the river was rising again at Dallas, with the gage reading 23.2 ft. at 7 a.m. By 7 a.m., Dec. 1, the stream had risen to 28.6 ft. and continued to rise until the 6th when the highest stage, 38.4 ft., was recorded. After that the water receded and was within banks by the 13th. The high-water mark at Dallas is placed at 56.5 ft. and occurred in June, 1866. Since a river station has been maintained at Dallas, the highest recorded was 52.6 ft., in May, 1908.

At Long Lake (near Palestine) 109 miles below Dallas, the Trinity attained a width of 1¼ miles. The stream rose steadily and rapidly from Dec. 1 to 9, when the maximum gage reading (49.5 ft.) was recorded. The subsequent fall was slow and the water did not get fully within banks until Dec. 22. This stage is 2.3 below the high-water mark which occurred on June 4, 1908. The damage all along the Trinity was at a minimum.

The reported damage is as follows:

Loss to buildings, municipal plants, bridges, etc., but not railroad or trolley lines	$56,300
Crops which may have been housed or may not	39,500
Live stock and other movable property	22,500
Loss due to suspension of business, including wages of employees	17,500
Unclassified	103,000
Total	$238,800

Tables of Statistics

The accompanying tables record the rainfall preceding and accompanying the floods and the river stages. Tables A give the inches of daily rainfall on the five watersheds in the flooded district, on the last 10 days of November and the first six days of December. Tables B give the river stages at river stations on the four flood rivers.

Production of Explosives in the United States in 1912—The total production of explosives in the United States during 1912, according to figures compiled by the Bureau of Mines (Technical Paper 69 by Albert C. Fay) was 244,696 tons. This compilation is the first publication of the Bureau relating solely to the production of explosives. It is intended hereafter to list such data annually. The amount of coal produced per pound of explosive varied from 0.86 tons in Arkansas, Oklahoma and Texas, to 5.82 tons in Maryland and Virginia. Deaths by explosives numbered 133 men; in 1911, the number was 134, and in 1910, 176. The figures tabulated represent the reports of 44 manufacturers of explosives. A rapid increase in the production and sales of permissible explosives occurred in 1912. In 1902, only about 5.5 tons of permissible explosives were used in coal mining; whereas, in 1912, about 9000 tons were used. An explosive is called a permissible explosive when it is similar in all respects to the sample which passed certain tests by the Bureau, and when it is used in accordance with the conditions prescribed. Furthermore, it must meet the following conditions: (1) That the explosive is in all respects similar to the sample submitted by the manufacturer for test; (2) that detonators—preferably electric—are used, of not less efficiency than prescribed, viz., by weight 90 parts mercury fulminate and 10 parts potassium chlorate (or their equivalents); (3) that the explosive, if frozen, shall be thoroughly thawed in a safe manner before use; (4) that the quantity used for a shot does not exceed 1½ lb., and that it is properly tamped with clay or other noncombustible stemming. Technical Paper 71 describes the permissible explosives tested prior to Jan. 1, 1914.

Some Problems in the Design of Small Water-Works Systems*

By William S. Johnson†

It is the lot of most engineers and water-works superintendents to have to deal almost exclusively with small things, to have to solve innumerable petty problems, and to solve them, generally, without the assistance of books. The engineer will find details of the greatest dams which have been constructed and of the great aqueducts, but very little that will help him in designing a 20-ft. dam or a system of small water pipes. Page after page is devoted to the things which not one engineer in a thousand ever has an opportunity to design, with but little or no space for that which every engineer is almost certain at some time to want to know.

In the state of Massachusetts there are 215 water-supply systems, and of these, 152 were installed before the population of the towns they supply was 5000, and 111 or more than half are now still supplying towns of less than 5000. In fact, the opportunity seldom comes to design a complete system of works for a large community, the larger systems being extensions of the system designed for the small town. As there are only four towns in Massachusetts having a population of more than 3000, which remain unsupplied with water, it is likely that, in this State at least, the problems arising in small systems will be more numerous than the problems connected with the larger systems although perhaps not so interesting to any but those immediately affected.

It has been my lot to put in a number of small water-works plants, and it has surprised me to see how easily 10% of the cost of construction may be saved by a thorough study of the problem. I have also found that many problems over which I have worked have been solved by others who have kept the results to themselves, not because of unwillingness to part with the information but because the matter seemed too small to be of general interest. It is with a view of encouraging the discussion of the problems connected with small water-works installations, as well as to give a few of the results of my own experience, that this paper is presented.

Time for Which Works Should Be Built

The works should be designed for a long time in the future, but the design should provide for as little immediate construction as is possible except where the cost of extensions or increased capacity will be much more than the cost of doing the work in the beginning.

To build works for a long time in the future assumes a power of prophecy which most of us do not possess. It is impossible to foretell the future growth of the whole or any part of the community. The advancements in the art of water-supply engineering are so rapid that portions of the plant are likely to become obsolete before they are worn out. The requirements of the public which uses the water are changing very rapidly. For these reasons it is desirable to build only for the immediate future, and to plan for additional works to be constructed as they become necessary.

*Abstract of a paper read before the New England Water-Works Association, Mar. 11, 1914. The full paper, with many tables and diagrams here omitted, will appear in the "Journal" of the Association.

†Sanitary and Hydraulic Engineer, 101 Tremont St., Boston, Mass.

Capacity of the Plant

The capacity of the distributing system is determined, in the case of the small town, by the fire-protection requirements solely. One good effective fire stream will use water at as great a rate as the ordinary town of 5000 inhabitants will require for domestic purposes during the hours of maximum draft.

The quantity of water which will be drawn from the sources of supply depends upon the population to be supplied, the character of the residences supplied, the care taken to prevent leaks and other wastes and the use of water for manufacturing or mechanical purposes. [The author next shows that it is difficult to forecast these factors in the case of small towns since some unforeseen development, like the establishment of a large factory, may double the population of a town within a few years, and, on the other hand, the loss of a large industry may cause a loss of half the population.—Ed.]

A future per capita domestic consumption of from 75 to 100 gal. per day for ordinary small towns does not seem unlikely and in the case of towns having large estates and a large area of well kept lawns the consumption may be much larger.

Requirements for Fire-Protection

Metcalf, Kuichling and Hawley, in a paper before the American Water Works Association, state that "the cost of the portion of the water-works plant involved by fire-protection, probably constitutes from 60 to 80% of the entire cost of the physical property in the case of communities having less than 5000 population." This is undoubtedly true except in those places where it is necessary, in order to secure water of sufficient purity for domestic purposes, to go to a large expense in obtaining it or in its purification.

In a small town, it is usually necessary to depend entirely on hydrant streams without the use of steamers and it is essential, therefore, that the works, either by themselves or assisted by some outside source, should furnish both the requisite quantity of water and the proper pressure with which to fight the greatest conflagration which is likely to occur, and to do this under the most unfavorable conditions in regard to domestic consumption and quantity of water in reservoir or standpipe.

The standard fire stream is now considered to be that thrown by a 1⅛-in. smooth nozzle, discharging 250 gal. per min., and it is generally considered by the insurance engineer that a hose stream which does not throw 200 gal. per min. is not a good stream. There are many cases, however, where smaller streams throwing from 150 to 175 gal. per min. would furnish reasonable protection and this is all that a town would be justified in providing in some districts. In the outlying sections of small towns, any fire which gets sufficient headway in the ordinary building so that it cannot be conquered with two streams of 150 to 175 gal. each is not likely to leave much of value if it is extinguished by using six streams. In such cases, the value of the water is chiefly in saving adjacent buildings and for this purpose even small streams are of great value.

For streets in a district where the houses are small and occupy comparatively large lots with no prospect of any considerable increase in density of population, and where extensions of the mains are not likely, a hydrant which will furnish 300 gal. per min. under a suitable

hose to any building in the territory supposed to be covered by this hydrant will be good fire-protection. More is desirable but the advantages are not sufficiently great to warrant the expense of larger mains to secure it.

In a district where the houses are nearer together but where there are no business blocks, apartment houses or other large buildings, it should be possible to get 500 or 600 gal. per min. at any point.

Where there are business blocks and other large buildings and where the buildings are very close together, as they frequently are in the center of a small village, it should be possible to get 1000 gal. per min. Where there are factories or other special fire risks, a much larger quantity may be necessary and a special study should be made of each case.

The pressure required at the hydrants while the hydrants are being used should be great enough to force the water through the greatest length of hose which will be used and throw it to a sufficient height to cover any building. The hydrant spacing and the pressure should, therefore, bear some relation to each other. The accompanying table, taken from a paper by E. V. French, gives the limit of a good efficient fire stream with different lengths of good rubber-lined cotton hose, with a constant pressure of 60 lb. at the hydrant, with moderate wind. The table also gives the corresponding amount of water which would be discharged.

HEIGHT AND VOLUME OF ONE 1⅛-IN. STREAM FLOWING FROM A SMOOTH-BORE NOZZLE

Length of hose	Limit of height, ft.	Discharge, gal. per min.
100	67	250
200	59	222
300	52	206
400	44	188
500	40	178
700	33	158
1000	25	140

The table shows the importance of having hydrants near the buildings to be protected. Unless the hydrants are near enough to furnish water at the fire under a good pressure, the expense of large pipes and a high reservoir is largely wasted. The cost of a two-way hydrant in place is about $40 and in the ordinary distribution system about 8 hydrants are required per mile of street main to keep the hydrants within 250 ft. of every building in the territory covered, so that the expense of the hydrants is very small compared with the expense incurred in other parts of the system to obtain efficient fire-protection. In general, hydrants should not be more than 500 ft. apart in the outlying sections. In the more closely built-up sections they should be so spaced as to make it possible to get the number of streams which are considered necessary at any particular point with the use of not more than about 300 ft. of hose for each stream. This figure may be modified, however, if the pressure is unusually high and should be if the pressure is unusually low.

The minimum pressure desirable for good fire-protection with hydrants spaced as suggested is about 50 lb. per sq.in. at the hydrants when they are in use. This pressure will give, with 300 ft. of best quality hose and a 1¼-in. nozzle, a stream of 185 gal. per min., which can be thrown to a height of 44 ft. With 200 ft. of hose, the quantity thrown would be about 200 gal. per min. and the height would be increased to 50 ft. There are cases where in the higher sections of the town these pressures are almost impossible and in such places the hydrants should be so located as to require as little hose as possible.

In the case of thickly built-up villages, the pressure should be 60 lb. per sq.in. at the hydrant when the water is being drawn at the maximum rate. This pressure will give a stream of more than 200 gal. per min. with 300 ft. of hose and with 200 ft. of hose will send 222 gal. per min. to a height of about 60 ft.

The size of the mains depends entirely on the requirements determined on to give fire-fighting facilities and on the head available. When these are known, the system can readily be designed. Generally, however, the head which can be secured is not fixed but can be made whatever is desired by putting in additional expense and the determination of the most economical arrangement of height of reservoir, size of pipes and spacing of hydrants is a matter for careful study.

The rule adopted in many places to put in no street main less than 6 in. in diameter in most cases works out properly but there is no excuse for it as an arbitrary rule. A short street will many times be better served with a 4-in. pipe than other streets in the same system with 6-in. mains and the money saved by using the smaller pipe could well be expended in strengthening those parts of the system which are weaker. The standard should be the quantity of water the pipe will deliver and the head under which it delivers this amount. If a 4-in. pipe will do this satisfactorily, there is no good reason why it should not be used.

The loss of head due to friction in a 6-in. pipe which has been in the ground for some time, when water is being drawn at the rate of 300 gal. per min., is about 10 ft. per 1000 ft. of length, and this figure, together with the required pressure at the hydrant of 50 lb. per sq.in. should, in general, determine the allowable length of 6-in. pipe as a dead end.

The maximum desirable pressure is a matter on which there is much disagreement, but the limit is constantly being extended. If it should prove to be more economical to have a system where the pressures run up to 150 lb., there would seem to be no good reason why this should not be done in a new system of water-works and it would be likely to prove much more satisfactory than to maintain two levels.

In 86 small towns in Massachusetts the average static pressure in the central portion of the town is 79 lb. per sq.in. Nine of these towns have pressures of less than 50 lb.; 33 have pressures of from 50 to 75 lb.; 31, from 75 to 100 lb., and in 13 the pressure is more than 100 lb.

Pumping Plants

The development of the oil and gasoline engine has done much to make water-works systems for small places financially possible. When the only feasible pumping machinery was the steam pump, the cost of installation of pumps and boilers, the cost of the pumping station to house them and the cost of maintaining the plant made water-works practically out of the question unless a gravity supply could be secured. With the new form of engine, however, the conditions are quite different. The cost of the machinery has been greatly reduced, the cost of the station is much less and the cost of operating is reduced to a minimum on account of the fact that with oil or gasoline there is no consumption of fuel except while work is being done, while with a steam plant a large proportion of the coal is used in banking the fires and getting up steam.

Electricity is also becoming an important factor in connection with small pumping plants, although the cost of current is so great that there are few places where oil or gasoline are not more economical, except for auxiliary plants used only occasionally.

Pumps should usually be designed for the greatest economy in doing the work which they are called upon to do regularly in supplying the domestic needs of the town, without regard to their use for fire-protection purposes. It is seldom feasible in the small system to have pumps of sufficient capacity to be of very great value in case of fire, and dependence for fire-protection should be placed on water stored in a reservoir or large stand-pipe or tank, or on some connection with factory pumps through which a large supply of water can be quickly secured. With increased size of pumps it is necessary to have a larger force main, a larger suction pipe, more wells, if the supply is taken from driven wells; in fact, a considerable portion of the plant must be increased in size and made more expensive in order to operate large pumps.

Large pumps are somewhat more efficient than small ones and if an attendant remains at the station while the pumps are in operation there is a saving in the shorter hours required with the large pump. With the oil engine, however, or with electricity, constant attendance is unnecessary, especially in the case of the smaller plants.

Pumping machinery should always be provided in duplicate, and works, although designed to run most economically when one unit is in operation, can be operated, if necessary, at double capacity with a somewhat reduced efficiency. A plant designed for a community which will use from 100,000 to 150,000 gal. per day, should generally have a capacity of about 250 gal. per min. for each unit. This would mean the operation of one of the pumps for from six to ten hours each day. Such a plant would give two large fire streams in case of fire by starting both of the pumps.

Many of the pumping plants are undoubtedly of too large capacity for economy and the tendency is in recent years to make them smaller, especially when the power used is some form of explosive engine.

Distributing Reservoir

The design of the distributing reservoir is affected chiefly by the topography, the requirements for fire-protection and by facilities for pumping. In a much less degree it is affected by the consumption of water.

The effect of the topography upon the design is generally to change the reservoir from what is desirable to what is feasible. In a comparatively flat community it is practically impossible to store as much water at so great an elevation as is desirable and in such cases the distributing reservoir must be cut down and other portions of the system must be designed to do the work which should properly be done by the distributing reservoir.

When the topography is such that it is feasible to build a reservoir of any desired size and any height, the design is dependent almost entirely upon the requirements for fire-protection. Generally it is found that the desirable static pressure from the reservoir at the point where there is likely to be the greatest demand for water is from 80 to 100 lb., depending to a large extent upon the distance from the reservoir to the center of distribution.

The reservoir should be, if feasible, large enough to hold, at the required elevation, in addition to the domestic supply for 24 hours, a sufficient quantity of water with which to fight any fire which is likely to occur. A fire in the built-up portion of a village may take about 1000 gal. per min., or 60,000 gal. per hour. In general, the time during which this quantity will be required will not be more than from 2 to 4 hours. Applying this rule to the ordinary town with no large fire risks, the capacity of the reservoir or stand-pipe should be from 300,000 to 400,000 gal.

Weight of Pipe

The portion of the design in which theory plays the smallest part and in which even experience is apt to count for little is the determination of the thickness and weight of cast-iron mains. The static pressure which pipes have to withstand and the breaking strength of the cast iron are the only elements in determining the proper thickness of the pipes which are even approximately known and determining the thickness from these elements alone would give pipes of about the thickness of cardboard.

The formula used by this association is

$$t = \frac{pr}{\frac{1}{5}(16{,}500)} + \frac{p'r}{\frac{1}{5}(16{,}500)} + 0.25$$

in which t is the thickness of the shell in inches; r, the radius of the pipe; p, the static pressure in pounds per square inch; p', an assumed water-hammer in pounds per square inch; 16,500, the breaking strength of cast iron; and 5, a factor of safety.

The chief uncertainties in the determination of the proper thickness of pipes are the water-hammer, the effect of corrosion, the possibility of breakages in handling, the strains due to imperfect foundations or unequal settlement and the eccentricity of castings and other imperfections in the pipe. There is no reason why the water-hammer in a small system should not be kept below the figures ordinarily used in the formula.

There are few, if any, authentic cases where corrosion of a cast-iron pipe has caused its failure. In fact, if a pipe has been in the ground long enough to corrode, it seldom fails from any cause. The strains due to imperfect foundations and settlement, in the case of small pipes, can be neglected if proper precautions are taken during construction. The difficulties due to imperfections in the casting and to the handling of thin pipes are the most serious and to overcome these is the duty of the founders. That they will be overcome, if the engineers insist on light pipe, there is no doubt, for already much has been done along these lines; the cost per ton may be somewhat increased if lighter pipes are used, but this increased cost will be nothing like the saving accomplished by the use of the lighter pipe.

In my own practice, I have put in many miles of Class C pipe where the pressures run up to 115 lb. per sq.in. and have never known of a failure which would have been prevented by using thicker pipe. The breakage in the handling may or may not have been greater. In any case, it was not excessive.

For the ordinary conditions in a small town, I would never use a heavier pipe than the Class C and lighter pipes may safely be used in many cases.

Depth of Pipes

The depth to which street mains should be laid has been investigated by a special committee of this society and the experience of the cold winter of 1911-12 has given valuable if unpleasant experience to those who have had charge of works. The depth determined on affects the cost of the works materially, especially if rock is encountered, and if it is safe to reduce the depth it certainly should be done.

Theoretically, street mains might be laid at different depths in different soils, being a foot nearer the surface in clay than in gravel, but in the average New England town there are so many soils that it is not feasible to make any distinction. The only distinction which it would appear safe to make is in the case of places where the ground water always stands near the surface, where the pipes may be laid in shallow trenches. The freezing of the pipes is such a serious matter that it would seem to be unwise to take any chances in an attempt to save money on trench excavation. The best practice seems to be, for a climate like that of Massachusetts, to have the center of the pipe from 4.75 to 5 ft. beneath the surface.

An Oil Trap for Drainage from Locomotive Roundhouses

By George W. Wade*

Crude oil is used extensively for fuel on the Pacific Coast, and railways burn it in locomotives, power plants, stationary engines, etc. While it is a cheap fuel and very convenient in its use, it is filthy material to handle and great care must be exercised to prevent leakage. Particularly must care be taken around terminal yards where the oil is pumped from tank cars to storage tanks, where pipe lines are liable to burst and the oil set free to permeate the surrounding soil, where engines stand and drip, and where oil cranes are subject to leakage. In the roundhouses, where engines stand over pits while being overhauled and repaired, great quantities of oil become mixed with the sewage.

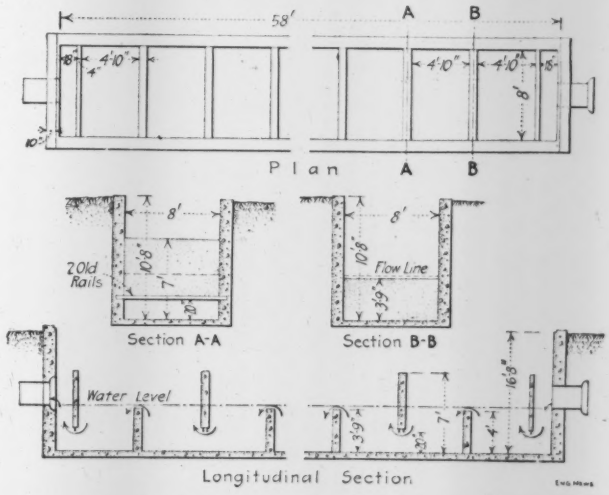
Cities will not permit this kind of sewage to run into the sewers, and this fact makes it necessary for the railway to build its own sewer line. The state laws make it a misdemeanor to discharge oil or other refuse injurious to fish into a flowing stream, and should this misdemeanor be temporarily overlooked by state authorities, the people living along the stream have cause for complaint. The water contaminated by the small oil globules is injurious to stock, chickens, etc. Therefore, it is incumbent upon the railway to separate the oil from the drainage originating in the roundhouse and shops before it leaves the premises.

The accompanying cut shows a very simple scheme for trapping the oil, and in addition to allaying trouble with property owners it pays a good interest on the investment in the saving of oil. The idea was first tried out at a Southern Pacific Ry. terminal with such success as to result in its adoption as standard.

The trap is virtually an open trough made of concrete divided into compartments by baffles for checking the water and allowing the oil globules to rise to the surface. The baffles built up from the bottom do not extend quite to the water surface, while the intermediate baffles extend a short distance below the surface. The sewage in flowing through this open trough passes alternately under and over the baffles.

The drainage from the roundhouse, engine pits, etc., is usually warm and with the oil thus diffused enters the trap as an emulsion. In working past the various baffles, its velocity is lowered, exposure to the air cools it and the oil is given a chance to separate itself and rise to the surface, while the water thus cleared passes through the opening under the baffle into the next compartment where the process is repeated. After the water has passed through all of the compartments, it is fairly free from oil. The water is so clear, in fact, that it is pumped back from the last compartment to the roundhouse and again used for washing out the boilers. This saving in water alone is very great.

The oil rising to the surface in the first three compartments and accumulating as a scum about an inch thick, is skimmed off with a long-handled dipper, deposited in a small tank and pumped back into the roundhouse to be burned in stationary engines. The value of the oil thus saved is equivalent to from 5 to 7% interest on the original investment.



Concrete Trap Chamber for Removing Oil from Sewage and Drainage Water at Railway Terminals

The trap also serves as a depository for boiler scale, which passes into the trap in solution and eventually precipitates to the bottom. When sufficient of this has accumulated in the bottom of the trap, it is removed.

The cost of such a pit built by the Southern Pacific Ry. is given in the following table:

COST OF CONCRETE OIL TRAP

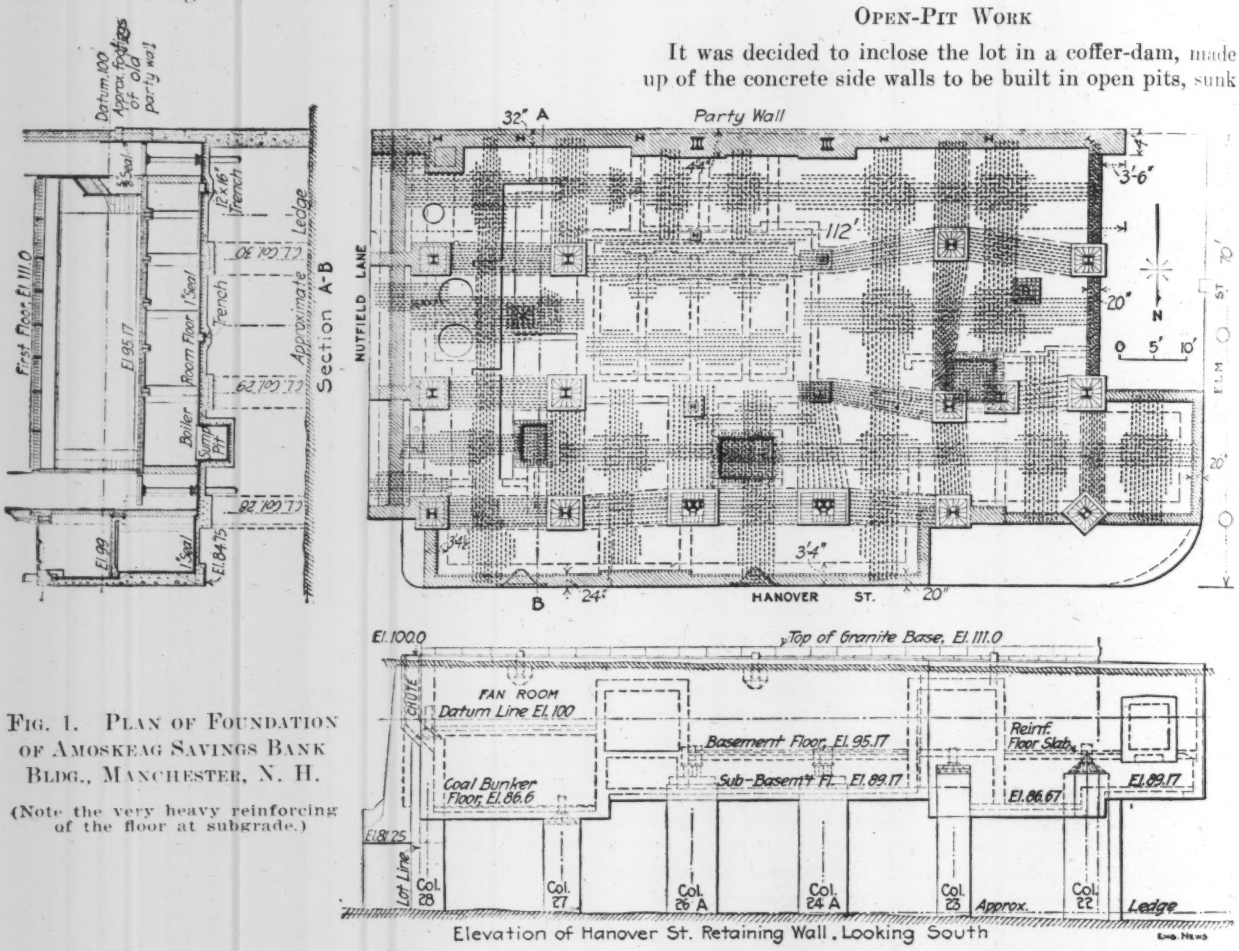
Labor	
Hand labor, excavating	$321.00
Forms and concreting	365.56
Hauling and handling material	39.75
Washing gravel for concrete	18.00
Team hire, grading excavated material	13.50
Hand labor, grading excavated material	31.00
Total	$788.81
Material	
Cement and rock	$151.20
Forms, nails, reinforcing, etc	126.00
Store and tool percentages, rentals, etc	45.22
Total	$322.42
Grand total	$1111.23

*Herald Hotel, San Francisco, Calif.

Difficult Foundation Work on the Amoskeag Savings Bank Building, Manchester, N. H.

By Charles F. Bowen*

There has recently been completed at Manchester, N. H., a ten-story steel-frame office building for the Amoskeag Savings Bank and allied interests. The building itself was shown in Engineering News, Mar. 5, 1914, p. 537, in an article describing a recent very severe fire which destroyed practically all of the block in which the building is located, and through which the Amoskeag building passed unscathed. The foundation work of the building was of peculiar difficulty, both on account of the water-bearing strata below the basement level, and on account of the presence of an adjacent party wall, which could not be approached except from the area to be excavated.



Elevation of Hanover St. Retaining Wall, Looking South

Fig. 1. Plan of Foundation of Amoskeag Savings Bank Bldg., Manchester, N. H.

(Note the very heavy reinforcing of the floor at subgrade.)

Fig. 1 herewith, shows the general plan of the foundation and some sections through the foundation walls. The building is on a corner lot fronting on Elm St., the busiest street in the city, and on Hanover St., also a very heavily traveled thoroughfare, and extending from Elm St. to an alley known as Nutfield Lane. The fourth side, opposite Hanover St., adjoined an old four-story brick building used as a department store, with a party wall 12 and 8 in. thick. The design called for a retaining wall surrounding the lot and forming the cellar wall. This wall was to go to rock on the party line and on Nutfield Lane; on Elm and Hanover Sts., the wall was designed to go only to subgrade. The interior column piers were to go to rock. Conditions encountered in construction materially changed some of those details, as described below. That water-bearing ground was expected is shown by the very heavy reinforcement of the concrete floor, which extends over the whole area. The grade of the sub-basement varies on account of different pits, vault foundations, engine footings, etc. On the site of the building, there was an old four-story brick structure, which was torn down to make way for the new building.

Open-Pit Work

It was decided to inclose the lot in a coffer-dam, made up of the concrete side walls to be built in open pits, sunk to the required depth, and to excavate the basement to grade after this coffer-dam was complete, and begin the interior piers as soon as the basement grade was reached. Previous to this decision, some borings showed sand down to boulders or rock approximately 40 ft. below curb, with ground water at about basement floor, but it was hoped that the walls could be sunk in the open with the aid of the pumps. The wall of department store building at the party line was 8 in. over the bank lot, and rested on a foundation of rubble, laid on the sand just below the basement floor of the old building. At the start of the excavation, foundation work was complicated by the refusal of the owner of the department store next door to

*184 Myrtle St., Manchester, N. H.

allow the contractor to enter the store for any of the building operations. It then became necessary to shore up the walls of the old building with raking beams and cantilever needles extending under the foundation of the new building. This refusal, further along in the work, complicated the sinking of the retaining wall and the pier foundation under the party wall.

Retaining-wall operations were started on the Hanover St. side. At first, the method of operating upon these walls was to dig trenches using long sheeting, and pitching internal sheeting when the first length could not be driven farther. At the same time, excavation was started on some of the interior piers by digging and sheeting in the same manner.

At about 13 ft. below the curb, water was encountered in these excavations in great quantities, and from 3 to 6 ft. below the water level a bed of fine sandy clay was found. The amount of water was so great that large pulsometer pumps were installed, and one of the piers sunk as far as possible, to be used as a sump. It was found, however, that the water came in faster than it could be pumped out, even from one of the piers, so that the sheeting method of construction was abandoned, and reinforced-concrete cribs, to be sunk under free air, were started for several of the piers. The retaining-wall construction was abandoned for the time being.

The cribs for the piers were built of reinforced concrete just the size of the finished pier, built on a steel-cutting edge, and it was intended to sink them by excavating inside the crib, weighting them down as the excavation proceeded and afterwards filling them with concrete, so that the crib and filling would form the finished pier. The same difficulty with water was found with this method as with the driven sheeting, the first crib driven finally bringing up on boulders which, on account of the excess of water, could not be reached and dislodged.

Compressed-Air Work

Pier Construction—The impossibility of sinking the cribs in the open being realized, it was decided then to sink them as compressed-air caissons; a plant consisting of a compressor, etc., three locks, and nine sections of collapsible shafting was then ordered and put in operation. When the air was put on the first crib, it was found to be hung up on two large boulders. Boulders of various sizes were encountered in all cases for last two to six feet. It was necessary to drill and blast many of these, which were embedded in fine clay and sand. There was nearly a foot of rotten rock on top of the ledge which had to be removed, but the ledge itself was finally reached at about 40 ft. below street level. It was leveled off, a seal of concrete put on, and the pier completed by filling up inside the caisson.

All of the piers shown as square in Fig. 2, which is a diagram of the foundation work as excavated, were sunk by this reinforced-concrete caisson method.

A test hole was drilled in this first bottom to determine whether bed rock, ledge or boulder had been struck. This hole ran into a seam, and the flow of water was so great that air had to be put on again to complete the tests. As nothing but good rock was found at a depth of 12 ft., it was assumed to be bed rock.

The sinking of the piers gave a good deal of trouble. They were started about 3 ft. above basement grade and were sunk without air to about a foot below water level. This gave a good seal, and air was held easily. Three pounds were put on at first, and this pressure increased sufficiently to keep the water back as the caisson sank. The first 4 to 6 ft. was in sharp, clean sand; then clay was encountered, varying in depth from 8 to 16 ft. At the under side of the clay were the glacial boulders embedded in the clay, with just below them a layer of coarse gravel from 4 to 6 ft. deep. This last stratum was very porous and gave much trouble in holding the air. Often, in the larger caissons, it became necessary to mud up tight, and only open up a small hole at a time. Sometimes even the bottom of the chamber had to be mudded. If air was reduced at all, water came in in floods. When working a caisson in this stratum, air would blow over the entire lot, often causing the abandonment of other

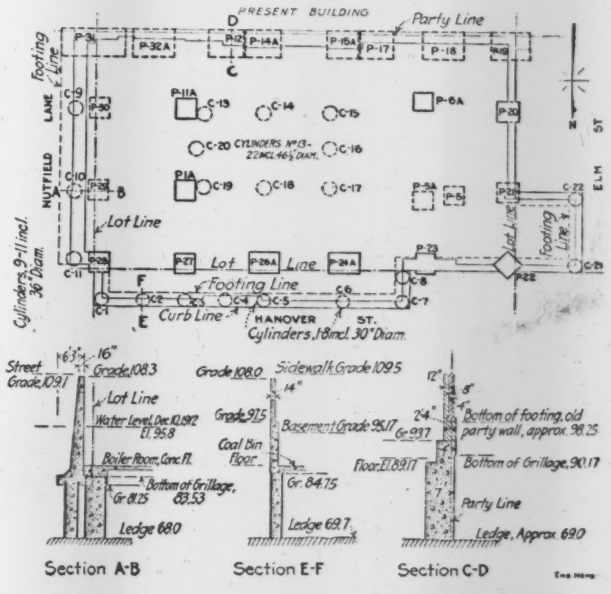


Fig. 2. Construction Diagram of Foundation

pits and trenches until the caisson could be sealed. The clay stratum was hard to force the caissons through, and on some of the larger caissons 110 tons of pig iron were used for weight.

By the time several of the interior caissons had been sunk, it became apparent that it would be impossible, or at least very difficult, to carry the party wall to rock, so it was decided to found this wall on piers reaching to rock, with the base of the wall at subgrade. All other retaining-walls were treated the same.

For these piers, steel cylinders, to be sunk under air, were ordered. They proved so successful that they were used for some of the interior piers. On Fig. 2, all of the piers shown as circles were sunk by the steel-cylinder method, all those shown square by reinforced-concrete caissons. Three different sizes were used, owing to exigencies of ordering and of time. Thirty-inch diameter cylinders were used for cylinders 1 to 8; 36-in. for cylinders 9 to 11; and 46½-in. for cylinders 13 to 22. The 42½-in. cylinders were the most economical and satisfactory form for the caissons; they were not so large as to require much pig iron to sink them, and yet big enough for a man to do good work in.

Party-Wall Piers—On the party-wall side, a special method of sinking the piers was required, on account of

the inability of working in the adjoining lot. A section slightly longer than the pier was breasted down for a depth of about 6 ft. and back under the wall and floor about 18 in. In this space, a working chamber was built, cast of concrete and reinforced, the top frame standing 3 ft. above the outside sheathing. This chamber was sunk 5 ft., and a crib 5 ft. high built on top of it and filled with concrete after a length of shafting had been placed. Again, this was sunk 5 ft. and another section of cribbing built, being filled this time with pig iron, and so on by sections of 5 ft. until rock was reached. The working chamber was then filled with concrete, the pig iron and shafting removed, and the crib filled with concrete to grillage grade. After setting sufficiently, a grillage was set and grouted. The party wall all this time had been supported alongside of each pier on the raking braces and cantilever needles. After the concrete of the piers had set, the lower portion of the wall was supported from them by upright timbers, the raking braces, of course, remaining in place, and these needles were then removed while the curtain walls were built between the piers. Eight of these piers were sunk, and the scheme, while slow and expensive, worked admirably, and no settlement showed in the adjoining building, except the basement floor, from beneath which ground was lost.

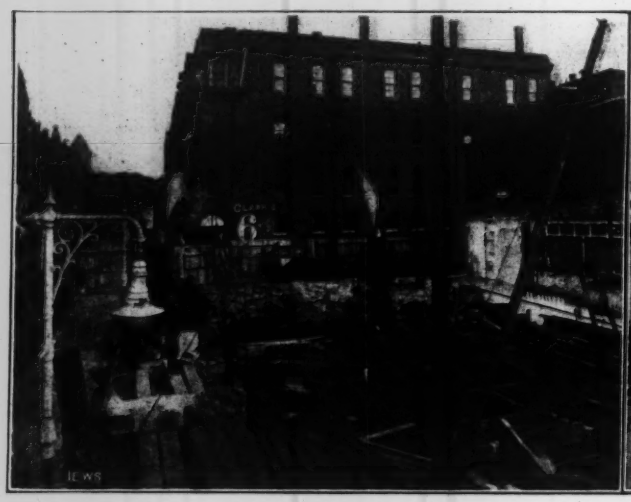


FIG. 3. FIRST STAGE OF WORK
LOOKING TOWARD NUTFIELD LANE DOWN HANOVER ST.

FIG. 4. HANOVER ST. SHEETING IN; ERECTION DERRICK UP; REINFORCED-CONCRETE CRIBS FOR PIERS PLACED

RETAINING-WALL CONSTRUCTION

All the cylinders were sunk on the Hanover St. side after the retaining-wall trench was down to grade. This trench was sunk in about three sections by fixing internal frames and driving sheeting. Each section was excavated to about 1 ft. below subgrade and sealed with about 8 in. of concrete, using tar paper or hay underneath to keep the clay-saturated water from coming in and ruining the concrete. The ground was very heavy and required extra strong bracing and shoring to hold it in place. Pulsometers were kept running constantly while excavating, and their suction was placed outside the final wall forms. Pumps ran until the wall was cast. Owing to excess of water and fineness of material, considerable ground was lost, causing settlement of the street, slightly damaging manholes, sewers, telephone ducts, etc., but not affecting buildings opposite.

On the Nutfield Lane wall, further trouble was experienced. This wall was built in three sections over the three 46½-in. cylinders which were sunk there. On the Hanover and Nutfield Lane corner, which was the wettest spot on the job, large streams of water brought in quantities of mud under the sheathing and the five-story brick structure across the way began to settle. A plate-glass show window was the first to go; then another; and the old cracks in the brickwork above the window arches began to open up. The trench was rushed to grade, and concrete poured, regardless of the forms and everything else, for the full width of the trench and 10 in. deep, until this run was completely stopped. Temporary shores were put against the building until it could be properly needled. No more trench was opened until the entire side of the building was carried on needles, after which no great difficulty was met with. Jacks had constantly to be followed up, but no further cracks appeared.

On the Elm St. side, very little trouble was encountered. One section only of the curtain wall which rested on the piers, gave any trouble. This was particularly bad. The bottom rose persistently, and a bottom of 3-in. plank had to be laid and jacked down. A concrete seal about 6 in. thick was put in and water allowed to rise. The next day, when the pit was pumped out and carpenters went down to build forms, no concrete nor plank could be found. All had sunk out of sight, due to weight of concrete on water-balanced soft bottom. The trench had to be mucked again and the bottom jacked down, but hay was put on top of the boards and under the concrete. This kept the clay back and the concrete set up. The clay was the most exasperating feature of the job, often ruining the concrete when hay was not used. Much of the floor gave trouble on this account.

FLOOR CONSTRUCTION

Finally, however, a good wall was secured all around the job, and the piers were all sunk to rock. The laying

FIG. 5. LOOKING ALONG HANOVER ST. TOWARD ELM ST. DURING CONSTRUCTION
(Old wall shored up on left; compressed air on cylinders at right and in the background; material, excavation, etc., stored in lot.)

of the solid reinforced-concrete floor was the next procedure. This was accomplished, except in the boiler room, with no great difficulty. When springs burst out, drains were laid to the pits where a sleeve coupling came flush with the forms and a nipple protruded. After the concrete had set, the nipples were removed and a plug inserted, thus removing the drain. While the floor was in the process of laying, three pulsometers were discharging to the sewers at the rate of 350 gal. per min.

The pits were also another source of trouble. The first pits, cast before the floor was laid, were all failures, in spite of precautions. They leaked badly. Other pits were cast solid to the floor and excavated to dimensions 24 hours later. This method was very satisfactory and was much cheaper than the method first tried. The pits that leaked were floored over with 7/8-in. matched plank; the section of a pump put into a sleeve came 3 in. above the floor, a 1-in. bent pipe put in in a similar manner, and a false floor of concrete poured. After this had set well, the pump was removed and the suction hole and vent hole were plugged. The method proved quite satisfactory.

The remainder of the work was carried on without much difficulty.

The views herewith show the congestion of the lot during the construction of the foundations.

PERSONNEL

The building is owned by the Amoskeag Savings Bank. The architects were Hutchins & French, Boston, Mass. The contractor for the entire work was the R. H. Howes Construction Co., of New York City. Frank G. Babcock was Superintendent for the contractor, and Joseph A. Power for the architects.

Prevention of Dust Explosions in Grain Elevators—Some years ago the Pennsylvania R.R. Co. had a series of fires in shaving-storage bins of the Altoona boiler plant where wood-refuse was fed to the boiler furnaces from a collector system. From the bins down-spouts led to the boilers; the main stack had a damper regulator and when this stopped the draft through the furnace, the flame was led back through the spouts to the bin. After investigation by the Motive Power Department, the trouble was eliminated by blowing the material into the furnaces by means of steam jets placed in the discharge pipes. Also the furnaces were extended back to improve the combustion.

A recent dust explosion in one of the company's grain elevators was reported on by the Motive Power Department and resulted in the use of similar means for eliminating this hazard. Dust and refuse was being blown into the boiler furnaces of the elevators. The serious explosions had always occurred when the fan was being stopped. The path from the furnace back through the down-spout, separator and vent pipe (from separator to stack) formed a by-pass between the boiler furnace and the stack when the boiler dampers were closed. The draft in the stack was sufficient to reverse the direction of the flow of dust through the down-spout and burning particles of chaff and dust were carried up this spout causing rapid ignition of dust therein and in the separator, giving the effect of an explosion.

Steam jets were recommended placed near the bottom of the down-spout together with a slight lengthening of the furnace. The steam jets recommended were of the expanding-nozzle type having a diameter at throat of about 1/8 in. Two were recommended placed in each dust pipe. These nozzles would each waste about 1/2 b. hp. with full boiler pressure. It was also recommended that the main boiler damper be arranged with a stop to prevent complete closure when the damper regulator operated.

The Committee on Blower Systems of the National Fire Protection Association has commented on this scheme and has recommended that the venting air pipe between the separator and the boiler stack be disconnected from the stack and that a washing apparatus be installed to remove the dust. In the pipe conveying refuse to the boiler, an automatic damper would be installed and arranged to close as soon as the blower in the grain elevator stopped—From a report of J. T. Wallis, General Superintendent of Motive Power Pennsylvania R.R., printed in the Quarterly of the National Fire Protection Association, April, 1914.

Laying a Wood-Block Pavement with Cement-Grout Filler, Cambridge, Mass.

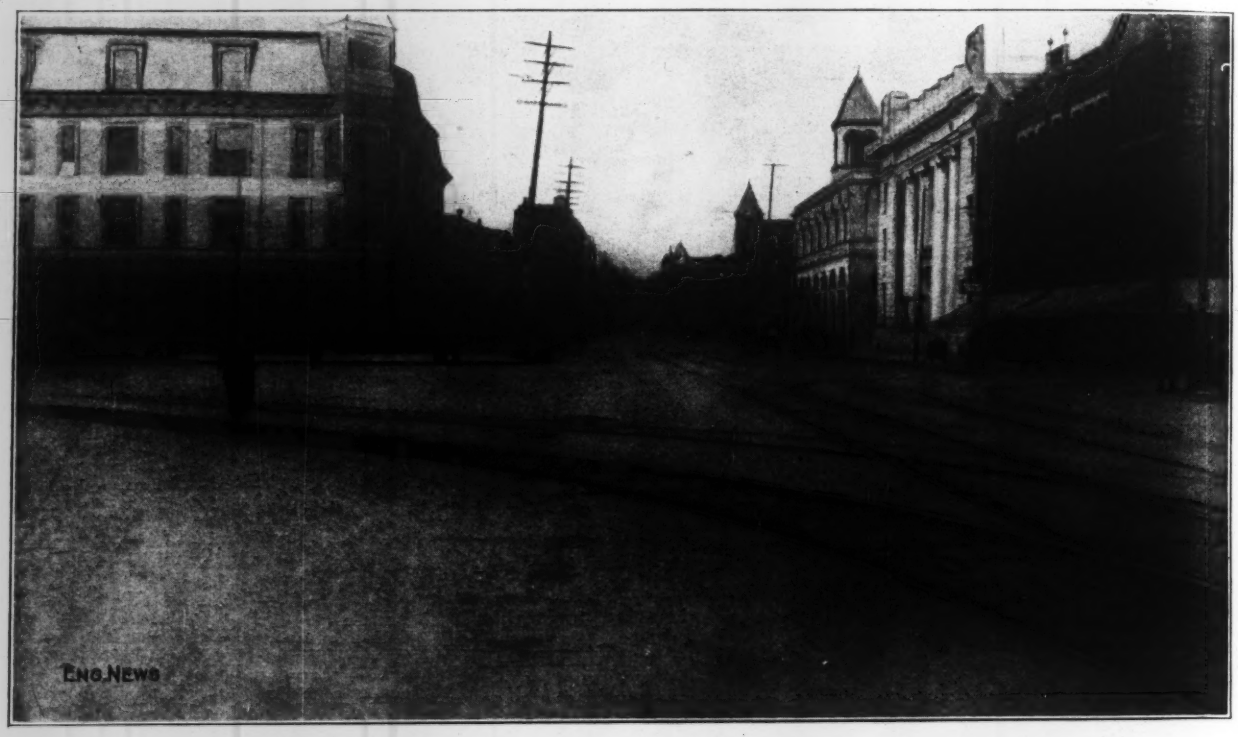
By L. M. Hastings*

One of the most satisfactory pavements which has been laid in Cambridge is a portion of Massachusetts Ave., recently repaved with wood block, having cement-grouted joints.

The Cambridge Main St. subway of the Boston Elevated R.R. Co. was constructed along this avenue from Lafayette Sq. to Harvard Sq., much of it in open cut. As the railroad company was obliged to restore the pavement it was deemed a favorable time for the city to cooperate and put down a first-class pavement.

Blocks—The blocks were of southern long-leaf yellow pine, having 80% heart wood of satisfactory texture and containing not less than five annual rings per inch. The wood was impregnated with 20 lb. of preservative oil per cu.ft. of wood, by any satisfactory process which would give the required results. The oil had a specific gravity of not less than 1.12 at 38° C. and contained not more than 5% of soluble matter and was free from petroleum or asphaltic residues.

During the hot weather of the first year, "bleeding" of the heavy oil from the blocks occurred. A heavy coat of sand was spread over the pavement where needed, which absorbed the tar and made a tough sheet or seat, some of which still adheres to the wood blocks as a kind of wearing surface.



Central Square, Cambridge, Mass., Paved with Wood-Block with Cement-Grouted Joints

The subway roof was, in places, quite near the surface and formed a rigid base upon which a thin layer of soil rested. At the sides of the subway, however, the soil had been disturbed to considerable depths. To avoid the unequal settlements in the pavement which would result from these conditions, it was determined to wait for as long a time as possible for natural settlement to take place before any work in paving was done. The subway at these points was completed in 1910. The paving was done in 1912 and 1913, and so far, no settlement worthy of note has occurred.

Base—The base was formed of 5 in. of cement concrete mixed by machine in 1 : 2½ : 5 proportions. Bank sand and power-screened gravel stone were used for aggregates, the gravel being of excellent quality and somewhat cheaper than broken stone.

Laying Blocks—The blocks were laid on a 1-in. bed of equal parts of cement and sand mixed dry, "struck" by a movable board to a true surface. After laying, the blocks were given a final inspection and any imperfect ones were thrown out. The blocks were finally thoroughly rammed by hand rammers. Expansion joints were placed at each curb, and transverse expansion joints were put in every 30 ft. These joints were ½ in. to ¾ in. wide and were run nearly full of an asphaltic compound, which was fairly soft and elastic, yet did not run in hot weather, making a very satisfactory filler indeed. At the first rain after the blocks were laid, many of these joints closed up entirely and in some a slight raising of the paving occurred. With continued traffic, however, most of the joints were forced back into place.

The joints between blocks were thoroughly filled with a 1 : 1 cement and sand mixture applied dry in two layers; afterward the pavement was wet with a hose and

*City Engineer, Cambridge, Mass.

thoroughly flushed, and the grout broomed into the joints, the water causing the cement in the joints and bed to fill all interstices.

One portion of Massachusetts Ave. was unusually wide and carried a rather heavy traffic; upon this portion, 4-in. blocks were used, the rest of the blocks were 3½ in. in depth.

Pavement Crowns—The street has a longitudinal grade of about 0.60%. It was found that a crown of ¼ in. per ft. gave excellent drainage and made the most effective looking street. This crown was adopted as standard where possible. The crown as actually used varies from ⅛ in. to nearly ⅝ in. per ft. This last seems and looks excessive but as a matter of fact it has not been found to make the pavement dangerously slippery.

Drainage—Owing to the peculiar shapes of the two squares, Central Sq. and Harvard Sq., which were included in the repaving, some long drainage lines across these squares developed, several being 120 to 150 ft. long. Drainage was effected by raising the grade of the street-railway tracks, where it was necessary, and keeping the slope from the gutter constant to near the center of the street. In but one case was it necessary to place a catch-basin elsewhere than at the gutter.

With regard to that bugbear of wood-block pavement —*its slipperiness*—experience here indicates that trouble from the cause is usually exaggerated. When conditions make the pavement slippery, the remedy is simple, viz., sprinkling with sand. This is not often required. During the two winters of 1913 and 1914, sanding was required only 8 or 10 times each season.

Cost Data—The entire work of excavating, grading, laying the base, laying blocks, ramming, grouting, etc., was done by city day labor without much previous experience, working 44 hr. per week at $2.25 per day, or at about 31c. per hr. for common labor. The 4-in. blocks cost by contract $2.59 per sq.yd. and the 3½-in. blocks cost $2.29 per sq.yd., delivered on the work. In all 15,276 sq.yd. of 4-in. block pavement was laid at a total cost of $4.11 per sq.yd., and 12,051 sq.yd. of 3½-in. block pavement was laid at a cost of $3.81 per sq.yd.

Reinforced-Concrete Jetties for the Control of Shark River Inlet, New Jersey

By Robert A. Lufburrow*

For years there has been a tendency toward closure at many of the inlets on the New Jersey seacoast. During the past sixty years Shrewsbury Inlet at Seabright, Cranberry Inlet near Sea Side Park, Old Egg Harbor Inlet, and Brigantine Inlet, just south of Atlantic City, have closed entirely, while Shark River, Manasquan and Barnegat Inlets have greatly deteriorated, and the first named has at times entirely closed. The importance of these New Jersey inlets is local and the commercial interests involved have not been thought such as would warrant expenditures by the Federal Government except in two cases; one of these was at the Manasquan Inlet and the other at Cold Spring Inlet. At Manasquan, timber jetties were built, but they have not proved successful. At Cold Spring Inlet, extensive improvements were made. A large harbor was dredged and parallel jetties over 4000 ft. long were run out to sea. The width of the channel was over 700 ft. The Federal appropriation for the work was about $2,000,000.

The Shark River Inlet Improvement is unique in that it is the first to be undertaken under State aid and control. Timber jetties have heretofore been constructed there by the Monmouth County authorities, but have not proved effective. The lines of these jetties are shown in Fig. 1.

It is important that this inlet be kept open so as to admit the tides freely, because its closure and the resultant freshening of the water in the bay means unsanitary conditions, and the loss of oysters, crabs and other marine life. Furthermore, this and the Manasquan Inlet are the only harbors of refuge for small boats between Sandy Hook and Barnegat.

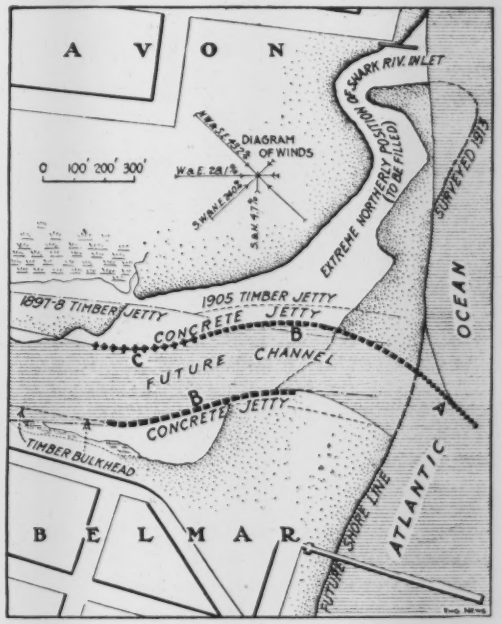


Fig. 1. Shark Inlet, New Jersey, Showing Present Conditions and Expected Conditions When New Jetties Are Built

In the spring of 1911, the Legislature of New Jersey appropriated money and directed that plans be made for the permanent improvement of the Shark River Inlet. The work was put under the supervision of the Geological Survey. In the autumn of 1911, their consulting engineer, C. C. Vermeule, was instructed to proceed with the preparation of plans and estimates. In his preliminary report, Feb. 5, 1912, he stated that "adequate works cannot be constructed for less than $58,000," but added that if further investigation showed certain extensions necessary, the cost might reach $71,000. He also asked for further appropriation to continue the investigations. The appropriation being granted, the plans and final report were submitted Oct. 21, 1912. During the following winter the Legislature made a further appropriation to construct the works in accordance with Mr. Vermeule's plans, on condition that it be supplemented by additional funds from the County and from the Boroughs of Avon

*Asst. Engineer, C. C. Vermeule, 203 Broadway, New York City.

and Belmar. Proposals were received on May 8, 1913, and the contract awarded to the Bay Dredging & Contracting Co., of Brooklyn, for a total of $57,654.20.

There was urgent necessity for strict economy in the carrying out of the work. Precedents could not be followed for the reason that no work undertaken under similar conditions has proven successful. Hence the theory upon which the improvement is based is of an original nature. Mr. Vermeule found from examination confirmed by previous experience, that under natural conditions, the channel at the Inlet invariably passed through the beach and thence seaward in a southeasterly direction. When other channels opened in an easterly or northeasterly direction, they were invariably short lived and unstable.

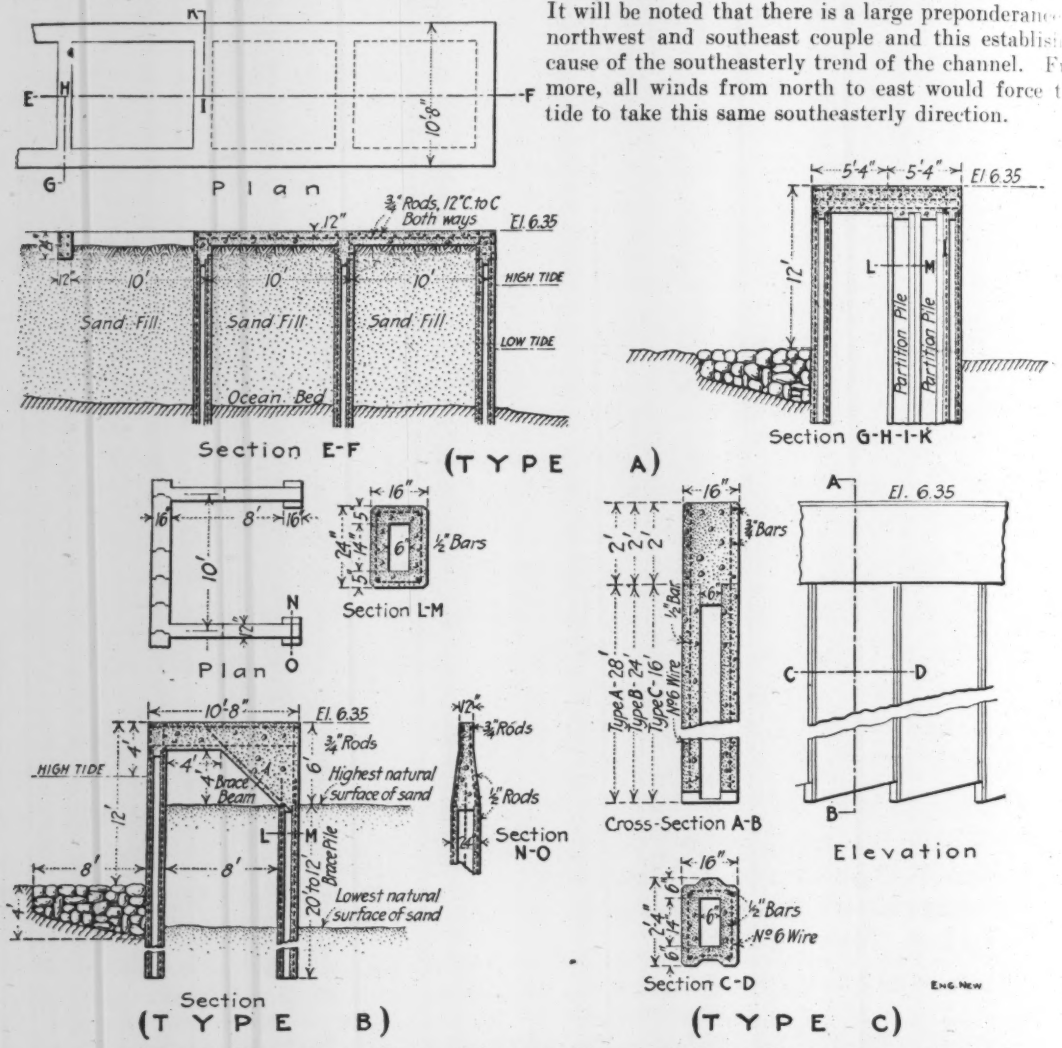


FIG. 2. DETAILS OF THREE TYPES OF JETTIES USED AT SHARK INLET

He deemed it important to make sure of the natural tendencies and work with them. Concluding that this southeasterly course must be due mainly to the wind, he made a study of the records of the winds at stations along shore during the eight years from 1903 to 1910 inclusive. (See Bulletin 6, Annual Administrative Report of the State Geologist for the year 1911.) He concluded that the wind worked in couples. For instance, the [illegible]west wind would influence the current to take a sou[illegible]sterly direction off-shore on the ebb tide, while the [illegible]east wind would influence it to take a northwesterly [illegible]tion on the flood tide, and consequently, it would f[illegible] the same track or channel for the two opposing win[illegible] His records show that the wind was either southeast o[illegible]orth-west 43.2% of the time, while it was north o[illegible]outh 4.7%, northeast or southwest 24% and east [illegible]west 28.1% of the time. (See Diagram of Winds, [illegible] I.) It will be noted that there is a large preponderance in the northwest and southeast couple and this establish[illegible] the cause of the southeasterly trend of the channel. Furthermore, all winds from north to east would force the ebb tide to take this same southeasterly direction.

The pressure of the prevalent southeasterly wind causes the sand to travel up the beach and constantly forces the inlet further northeast until it reaches the extreme northerly position shown in Fig. 1. Having reached this ultimate position, the inlet becomes shoal and the narrow neck of beach then cuts through in another place. This weakens the scouring effect of the current and eventually closes the inlet.

From these facts, it was concluded that the inlet must be confined by a strong jetty on the northerly side, that this jetty should be curved with the concave side toward the south, and must leave the beach in a southerly direc-

tion. The pressure of the moving sand will hold the current against this north jetty and the width and depth of the channel will be automatically regulated by the tidal prism. Hence all of the south jetty may be safely omitted except a sufficient part inside the beach to deflect the current on the ebb tide toward the north jetty, and resist any tendency to cut through the southerly beach. If continued across the beach, it would be impossible to determine in advance the correct location of the south jetty. If built too close to the north jetty it would tend to diminish the range of tide in the bay, if built too far from the north jetty it would be useless and sand would collect north of it. This omission of the south jetty effects a substantial saving in the initial cost of the work. It can be added later if desirable, when the width and depth of channel are determined. The reversed curve through the beach was adopted in part because inlets show a natural tendency to follow such a course, and in part because it will tend to keep the thread of the channel in a stable position which would not be the case with straight jetties. In other words, they act to a slight extent as reaction jetties.

A rational theory of the proper lines upon which the improvement should be planned having been reached, the next step was to design the structural features. The ordinary timber sheet-pile jetty had been found too light and was unable to withstand the pressure created by the piling up of sand behind it, and the scouring away of the sand on the channel side. The timber is fairly durable but the rusting of iron spikes soon weakens the structure. To secure greater strength, weight and stability, it was decided to use reinforced concrete. Three types of jetty were adopted, the general features of which are shown in Fig. 2. In each type, the principal jetty is composed of a line of reinforced-concrete sheet piling, each pile 16x24 in. in section, with the interior hollow, in order to reduce the weight of the pile for handling, and facilitate its drying out. Each pile is provided with a tongue and groove to hold it in alignment while being driven. After they are placed in position, the tops of the piles are thoroughly tied together by a reinforced-concrete cap measuring 16x24 in. in section.

Type A Jetty consists of a double line of sheet piling, 28 ft. long, with caps cast as described and tied together by reinforced-concrete beams at intervals of 10 ft. This type is used off-shore in the north jetty where it is exposed to heavy seas, and the off-shore end is further strengthened by transverse partitions of sheet piling at intervals of 10 ft., the whole firmly bound together by a reinforced-concrete deck, 12 in. thick. This, it will be noted, makes a strong cellular construction of reinforced concrete. To give weight to resist the pounding of the waves, the plans show a sand filling between the lines of piling, but for this there may be substituted a low-grade concrete which will remain in place in case of a minor fracture of the jetty. The deck of the jetty is 4 ft. above mean high tide. It is purposely kept low, as it is believed to be better to allow the heavy storm seas to break over it than to expose a greater height to the pounding of the waves.

Type B Jetty consists of a single line of reinforced-concrete sheet piling, 24 ft. long, braced at intervals of 10 ft. by a pile set 8 ft. back and tied to it by a reinforced-concrete brace beam. This type is used in both jetties where strength and weight are needed to deflect the course of the current, but where it is not exposed to heavy seas.

Type C Jetty consists of a single line of sheet piling, 24 ft. long, tied together by a reinforced-concrete cap, but not braced. This type is intended to protect the heavier jetty from being cut around by the action of the current and is used on the north side in shoal water and well back from the beach.

The channel side of the jetties is protected from scour by riprap, allowing for a depth of 8 ft. below mean high tide. The piles are manufactured on the beach and allowed to season before moving. The bottoms and sides of the forms are battened together and bolted in place, being used many times. The reinforcement consists of six smooth rods, ½ in. square, tied together with No. 6 wire every 12 in. The wire is bent with suitable loops at the mill. The reinforcement for each pile is assembled on the beach by slipping the rods through the loops and the whole placed in the forms and hung from spreaders. The piles weigh about 4½ tons each. As many of the piles were cast during the summer, the intense heat of the

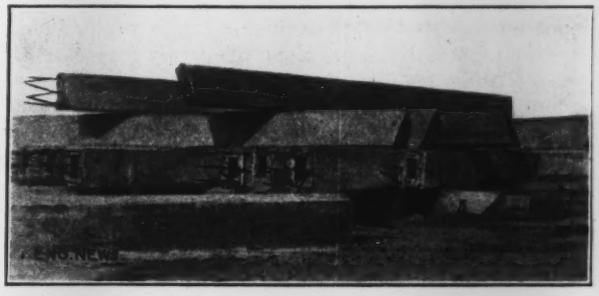


FIG. 3. REINFORCED-CONCRETE PILES FOR SHARK INLET JETTIES

sun on the sandy beach made it extremely difficult to prevent quick drying of the concrete and attendant shrinkage cracks. To overcome this difficulty, the piles were kept covered with tarred paper which was constantly wet.

The casting is done on runways of timber supported by wooden piles and carefully leveled up, and when seasoned, the piles are removed by the locomotive crane, tracks being laid between the runways for this purpose. These cracks are carried out to the beach and along the lines of the jetty, a temporary road bed of sand often being graded for this purpose. Where possible to work from the land, the locomotive crane is employed to hold the piles in position while they are being sunk by means of two water jets. Thus far no pile driver has been used, but the pile has been raised and suddenly dropped, its weight being sufficient to carry it downward and this operation is repeated until it has reached the proper depth. For constructing the offshore end of the jetty, it is intended that the tracks shall be laid on the top of the driven concrete piles. Inland, where the work cannot be prosecuted from the land side of the jetty, it is being carried on by means of floating derricks on scows which carry the pumps and other appliances for jetting. In places at a depth of 10 or 12 ft. below high tide, a stratum of hard clay, locally called marl, is encountered and is penetrated with some difficulty. Pieces of this material, on exposure to the air, become as hard as a shale rock. While this adds to the difficulty of driving,

it offers a firm hold for the piling and contributes somewhat to the security and stability of the work. This stratum is often from 12 to 14 ft. thick. Otherwise, the material encountered is generally a mixture of sand, gravel and sometimes sandy clay, which offers little resistance to driving.

The concrete consists of an unusually good natural mixture of sand and gravel found about three miles from the work. It has been originally intended to screen this before using and remix it in proportions that would produce a minimum of voids, but after elaborate experiment, it was found impossible to improve the mixture. The natural material runs very uniform and is so graded as to size that the voids are less than 20%. The mixture is practically in the proportion of 1 cement, 2½ sand and 5 gravel.

Up to the present time, about 1050 of the 1400 piles needed to complete the work have been cast. In the north jetty, 85 piles have been driven, extending from the low-water mark on the ocean side across the beach to the river. Ninety-nine piles have been driven in the south jetty. The piles of the north jetty, although as yet unprotected by the concrete cap, have been unaffected by the pounding of the waves during the past winter, which has been unusually severe along the Jersey coast.

It is fully realized that this is a somewhat bold attempt to accomplish the purpose of the improvement. While there is no disposition to under-rate the difficulty of measuring forces which must be dealt with, still an earnest effort has been made to adopt a correct design and one which although light, is the strongest possible within the limits of the appropriation. Bearing in mind that the ordinary movement of the sand is northward along the beach, and referring to Fig. 1, the location of the north jetty suggests that it might act as a sand trap and tend to close the inlet. This matter has been fully dealt with in the reports. It is pointed out that there is no possible design that will prevent the northerly movement of the sand, neither is there any way that the sand can be carried across the mouth of the inlet without entering at some stage of the flood tide. It is expected that some sand will be carried in during flood tide and the entire system of bulkhead lines and jetties for a half-mile up from the beach has been laid out, very gradually converging toward the beach to increase the velocity of flow and to insure so far as possible, the carrying out on the ebb tide of the sand which is carried in on the flood. When carried out, this sand will pass around the end of the north jetty, and thence northward along the beach. So long as the northerly bulkhead holds, the inlet must be held in a fixed position and must always cut its way out through the beach along the line of the jetty. Even if it should occasionally close, the gain from keeping it in a fixed position will be manifest and the expense of reopening it along the line of the jetty will be comparatively small, because it is only necessary to open a small channel and the scour of the water soon removes the remainder of the sand.

Incidental to this Shark River Improvement, private enterprise is now bulkheading the entire river upstream from the inlet, and also proposes to construct protection works along the shore of a type not heretofore used in this country. The seacoast protection works are being designed along lines which have been found successful in European practice. When these inlet and coast-protection works are completed, Shark River will afford a unique example of a scientific effort to solve the problems involved in the control of such inlets, the movement of the sand and the protection of sandy coasts.

Repairs to a Reinforced-Concrete Conduit Beneath a Drainage Levee

By H. H. Hudson*

A failure of a somewhat unusual character recently occurred to the reinforced-concrete outlet conduit of Levee District No. 1, in Mississippi County, Mo., necessitating repairs which are just being completed (May 8, 1914). The conduit forms an outlet into the Mississippi River, through the Government levee, for a system of drainage ditches which are to be built to drain approximately 20,000 acres of swamp lands. The conduit is placed at the foot of Big Lake. After flowing through the conduit, the water reaches the river through Big Lake Bayou. Both the Lake and Bayou will be deepened 12 ft. by the ditch. Until the ditches are constructed, the conduit will act as an inverted siphon, as the flow-line through the sewer is 12 ft. below the lake bed.

The footing of the conduit barrel is 13x170 ft., resting on capped pile bents. The barrel is a semicircular arch 10 ft. in diameter on 3-ft. bench walls. At the outlet end, there is a flood-gate, tower and hoist. The structure was designed to carry a 22-ft. levee, with 8-ft. crown and side slopes of 3 to 1 on each side.

Test borings showed that the soil at the site of the sewer was river sediment for about 20 ft. Under this was a thick stratum of sand. The piles supporting the sewer were driven to refusal in this sand stratum, using a 3500-lb. steam hammer. The concrete work was built in two sections, therefore there was a joint around the barrel of the sewer near the center. As was afterwards found, due care was not taken in joining the two sections. The longitudinal reinforcing was lapped but 1 ft. and no care was taken to get a good bond with the cement.

The concrete work was finished about Dec. 10, 1913, and immediately the work of constructing the levee fill across it was commenced. As the levee work progressed, it was noticed that the fill kept settling, and as the top was neared, this settlement increased until after being brought up to grade; the levee settled as much as 2 ft. in a night. This settlement was caused by the layer of river sediment not being stable enough to bear the weight of the fill, so it was continually squeezing out under the weight placed upon it.

Each day the levee was brought up to grade and each night it would settle. This continued for about two weeks, when the fill remained stationary for five days. On the morning of Feb. 1, 1914, a circular hole 12 ft. in diameter was found directly above the center of the arch. Muddy water flowing out of the conduit showed that there was a break in the concrete. As the conduit was working under water, it was impossible to determine the extent of the damage except by means of a shaft from above.

The intake end of the sewer was bulkheaded and a 10x10-ft. shaft started directly over the point of failure.

*With the Berthe Co., Engineers, Charleston, Mo.

This shaft was curbed and timbered strong enough to withstand the water pressure from the river, should the usual spring rise occur before the repair was made and the levee replaced. Centrifugal pumps were placed at the outlet end and the work of unwatering commenced. As the bulkhead had been placed under 12 to 14 ft. of water, and therefore could not be made absolutely tight, the accumulated head caused a great amount of water to pass through. It was necessary to install two 6-in. and one 4-in. centrifugal pumps before the water could be lowered enough to allow workmen to enter the sewer and calk the bulkhead from the inside. After this was done, the 4-in. pump was sufficient to handle the water.

When the shaft was carried down it was found that the failure was caused by the separation of the two sections at the joint. This break extended completely around the barrel of the sewer. Measurements and levels were taken and it was found that while the alignment and elevations of the intake and outlet were unchanged, one-half of the sewer, at the intake end, had been moved longitudinally a distance of 13 in. This movement was due, no doubt, to the pressure of the dirt fill against the head and wing walls of the structure.

Arch centers and forms were placed and the break filled with concrete. In addition to this, the two sections were anchored in the following manner. Two feet back from the edge of the break and on each side of it, holes 8 in. deep and 2 ft. c. to c. were drilled in the outside of the barrel, starting at the flow line on one side and running up the bench wall, across the arch ring and down the bench wall on the other side to the flow line. Next ¾-in. reinforcing bars were passed from each hole in one section to the corresponding hole in the other section. The ends of each bar were bent and grouted into the drilled holes. Over these bars a patch of concrete 1 ft. thick and 8 ft. wide was placed over the arch from the flow line on one side to the flow line on the other side. In making this repair it will be noticed that the flow of the water through the sewer is in no way retarded.

While this repair has not been completed long enough to have had a good test, there seems to be no doubt but that it will safely anchor the two sections.

Testing Check Valves*

By J. Walter Ackerman†

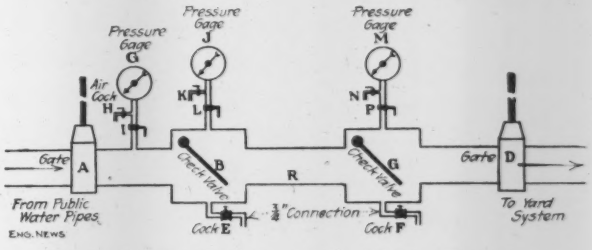
In the year 1908 the water department of the city of Auburn caused an examination to be made of the check valves of the mill and factory connections in the city of Auburn. And as these check valves were of the type that are bought on a competitive basis, and simply represented a design made looking toward an economy of material and labor, the results of this examination can be easily imagined.

It was found in many cases that even the locations of the valves were unknown to the factory, and some had been buried in the ground for a period of twenty years, without ever having been examined. The final result of this inspection was that each and every mill or factory using city water for fire-protection, and having a polluted auxiliary supply, was required to install double check-valves of a special design, to be placed in a brick or concrete vault, accessible at all times.

The specifications under which the check valves were made require that the seat ring, disk-holding ring, and screws, and in fact all moving parts, and the hinge pin and bushings of same be of bronze, the disk to be faced with medium-hard rubber, and liberal clearance to be made all around the clapper, the pin, the arm, etc. These specifications were largely determined by the inspection department of the Associated Factory Mutual Fire Insurance Companies of Boston, and they also had to meet with the approval of the water department.

The regulations are that they shall be tested once every six months by the water department, and taken apart once each year and examined for defects or obstructions, and during this latter inspection a representative from the Associated Factory Mutual Fire Insurance Co. is present.

Installation made in the city of Auburn is shown by the accompanying diagram. The two stop gate-valves *A*



Check-Valve Installation, Water-Works of Auburn, N. Y.

and *D* are so placed in line as to absolutely shut off the water from the check valves. On the entering side, between the first valve and the check valve, is a tap with cock and air vent, on which is placed the pressure gage *G*. Likewise, two other taps on the two check valves are made with the same type of connection. Tapped into the bottom of each of the check-valves is a ¾-in. connection, controlled by a cock.

The actual test is made as follows: Closing gate *A*, either the cock *E* or the air cock *H* is opened. The pressure at *G* only should fall if the check valve *B* is tight and the gate *A* is tight. It sometimes happens that the opening of air cock *H* releases the pressure so slowly that the back pressure on check valve *B* will not seat the clapper in valve *B*, and the gages both *G* and *J* will fall; while if the ¾-in. cock *E* is opened, the valve *B* will close tight. This simply gives the degree of sensitiveness of the check valve, and indicates its condition; for if the air cock does not show it absolutely tight, the drip *E* may. This generally shows that the rubber facing on the clapper is either coated with slime, or some small indentations occurring, allow the water to pass back through this valve. The conditions of tests are slightly different, depending upon whether a mill has one connection or two. If it has two connections there is always present the city pressure from the other connection coming back to the two valves; whereas, if there is only one connection there is only the static head, or else the fire pumps in the mill are started, and pressure created in that way. If the flow from *E* or *H* is continuous, it is an indication that there is a leak either through both check valves or through the stop gate *A*. If the pressure

*From "Jour. Am. W. W. Assoc.," March, 1914; read before annual convention of the Association, May, 1914.

†Engineer and Superintendent of Water-Works, Auburn, N. Y.

with *E* and *H* open drops on gage *G* only, and not on gages *J* and *M*, it is the gate *A* leaking; but to make absolutely sure, allow all the gages to assume the normal pressure, and then suddenly release *F*. If gages *J* and *G* drop, and *M* does not, and the flow continues, then it is an indication that the leak is through *A*, and not through *B* and *G*.

After the condition of gate valve *A* and check valve *B* has been thoroughly determined by the above method, then the opening of air cock *K* or drip *F* will disclose whether there is a leak on check valve *G*. And, as before noted, if it shows a leak with *K* open, and tight with *F* open, it simply does not seat properly under a low differential pressure. And this is important, because the valve is called upon to act when the fire pump raises the pressure above that of the water in the city mains. And there always will be a time when the pressure on each side is just equalized, and then the pressure on the mill side will begin to build up above that of the city side. And while the test may show from both the drips a tight condition, it will not show a tight condition when only the air cocks are used slowly, allowing the difference in pressure to be gradual.

In order that a number of trials may be made on check valve *B*, pressure should be taken from some source and introduced between the two valves. It is preferable in this case to take the pressure from the main on the mill side between check valve *G* and the mill or factory and allow it to come in through either the drip pipe *F* or some other place, in order to balance the pressure each side of check valve *G*. Then this bypass connection would furnish water for unlimited trials on check valve *B*, independent of check valve *G*, for any water which leaks through *B* would be replaced by the bypass connection, which, if it was not there, would soon be exhausted if check valve *G* was tight.

The actual value of the test is obtained after it is completed and the examination made of the interior to show actual conditions, such as tuberculations on the iron body, the smoothness of seat ring, the condition of the rubber facing on clapper, and the manner of the closing of the valve. And while the test is only to show working conditions, the examination shows the way the valves are living up to the requirements imposed upon them.

The rules in our department which control the installation of check valves are as follows:

No water pipes in any building or premises supplied with water by the city shall be allowed to receive a supply of water from any other source except in case of pipes used exclusively for fire protection that conform to the requirements given below:

No connection of the city mains shall be allowed with pipes having another source of water used for miscellaneous purposes except to a tank open to the air, nor shall such pipes have any physical connection with the pipes used for fire protection.

Between the pipes used exclusively for fire protection and the city mains there shall be two check valves placed between two positive valves and located in an accessible brick or concrete pit, with such valves, gages and connections as may be prescribed by the water board for each installation and for the purpose of testing. The check valve shall be of a type approved by the water board. The check valves shall be kept in working order by the consumer and shall be at all times subject to inspection and test by the superintendent of water-works, the cost of such test being borne by the consumer. The pure-water pipes that have direct connection with the city supply, before the same have passed through the aforesaid double check valves, shall be painted blue; the pipes used exclusively for fire protection shall be painted red; and the pipes carrying the impure water and that used for miscellaneous mill purposes but not for drinking shall be painted yellow. These different systems of pipes shall not have any physical connection with each other in the mill or factory.

There shall be placed on the discharge main of the fire pump a check valve and positive gate. The latter shall be kept closed and sealed by the superintendent of water-works, and opened only in case of fire or for the purpose of occasionally testing the fire system, but notice of such occasional test shall be given to the superintendent of water-works, and during the test the positive gate between the fire system and the City main shall be kept closed. During the weekly trials of the pump prescribed by the fire underwriters the water shall be discharged either through the relief valve of the pump or through hose connections from the pump.

State Control of Water Pollution in Illinois

By Thomas J. Healy*

To stop the pollution of the rivers and lakes of Illinois, the Illinois legislature has created a Rivers and Lakes Commission comprising three commissioners. The authority vested in the Commission is stated in Sec. 14 of the law creating the Commission, as follows:

It shall be the duty of said Rivers and Lakes Commission to see that all the streams and lakes of the state of Illinois, wherein the state of Illinois, or any of its citizens, has any rights or interests, are not polluted or defiled by the deposit or addition of any injurious substances, and that the same are not affected injuriously by the discharging therein of any foul or injurious substances, so that fish or other aquatic life is destroyed. And if, upon investigation, the Commission shall find that any of such streams and lakes are so polluted and defiled, or are affected injuriously by the discharging therein of any foul or injurious substances so that fish or other aquatic life is destroyed, it shall be the duty of said Commission to enter an order commanding the abatement of such nuisances within such time as may be fixed by the Commission.

The work thus far undertaken by the Commission in pursuance of this authority has been to notify through the public press and by letter, municipalities and others, to submit plans and specifications for any proposed new sewer system, especially when sewage is to be discharged into some body of water used by the public for domestic purposes. The Commission also investigates all complaints from any citizen relating to water pollution in any part of the state. Thus far, this plan has been satisfactory notwithstanding the fact that the submission of plans for the construction of sewers is not compulsory —which, in a measure, weakens the effect of the law.

Since July 1, 1913, the date when the law became effective, the Commission has had under consideration over twenty-five different applications and complaints involving stream pollution. When complaints, plans or specifications are received by the Commission, they are at once referred to the Director of the State Water Survey at Urbana. This official assigns an investigator to the case and subsequently forwards to the Rivers and Lakes Commission his report and recommendations. In the case of complaints, a summons is issued by the Commission for the offending parties to appear. The necessary witnesses are subpœnaed, the evidence heard by the Commission is transcribed, and an order containing the conclusions of the commissioners is issued. In the case of plans and specifications, the Commission approves or rejects the same. If those complained of (mostly cities, villages and towns) wish advice as to the method and plan to be pursued in correcting the abuse, this is given through the engineering department of the Commission.

*Member of the Rivers and Lakes Commission of Illinois, Transportation Building, Chicago, Ill.

Editorials

Abandoning Guarantees on Asphalt Pavement

We have frequently discussed in these columns the guarantee of maintenance for a term of years in paving contracts and have urged that this plan really operates to the detriment rather than the benefit of the taxpayers. The annual report of the General Asphalt Co. contains an indication of the extent to which the old plan of maintenance guarantees has been abandoned.

Eleven years ago (in 1903) the requirement of a guarantee was almost universal on asphalt-pavement contracts. In that year only 6.4% of the asphalt paving laid by the General Asphalt Co. was laid without a guarantee, and the average length of the guarantee period was 7.2 years. In the year 1913, over half the paving laid by the company was laid without a guarantee, the exact figures being 51.6%. The average period of guarantee for the remaining pavements which were laid under guarantee was only 2.45 years. The reduction in the average term of the guarantee is even more important than the percentage of pavements laid with no guarantee at all. Ten years ago the usual guarantee on asphalt paving was ten years, while fifteen years was the requirement in New York City. In one case, many years ago, a guarantee of twenty years was given on pavement laid in New Orleans.

City vs. Country

The remarkable extent to which the city, rather than the country, has come to be the dominating factor in all the Eastern United States, is brought out clearly in a Census Bureau bulletin just issued, giving estimates of the population for each year from 1911 to 1914 inclusive. The Census authorities draw the line between the country and the city at a population of 8000. Those dwelling in places with a population of 8000 or greater are classified as living in cities, while those living on farms or in towns and villages with less than 8000 population are classed as living in the country. On this basis, the Census Bureau estimate shows that in the United States in 1914 39,700,000 people are living in cities, and 59,100,000 are living outside cities.

In New England, the proportion of city dwellers is larger than in any part of the country, the proportion being roughly as 5 to 2, or 4,830,000 living in cities and 2,130,000 outside of cities. The proportion of rural population in New York, New Jersey and Pennsylvania is somewhat larger than in New England, notwithstanding the enormous concentration of population around New York City and Philadelphia. The figures for these three States are 13,500,000 in cities to 7,400,000 in the country. In the States from Ohio to Wisconsin, which a generation ago were considered agricultural, the city dwellers and country dwellers are now about equal, there being about 9,000,000 of the former to 10,000,000 of the latter. In all the territory south of the Ohio and west of the Mississippi the rural population is far in excess; or, in other words, there are in the various sections from three to six dwellers in the country for every one person dwelling in the city. In the three States bordering on the Pacific Coast, the city population again becomes prominent and the proportion of city dwellers and rural dwellers is about equal.

If a comparison between city and rural population were to be made on the basis of the objectionable features of city life, such as overcrowding, disease breeding, the existence of slums, etc., then the 8000 population which the census has assumed may be taken as a fair line of division between the city and the country. If, however, a comparison were to be made between those who dwell where they have the advantages of the city as compared with the isolation of the country, then the population should be fixed at a much lower basis. There are thousands of towns and villages scattered all over the country with from 1000 to 8000 population which have public water-supplies, public lighting systems, paved streets and sidewalks, municipal schools, facilities for public amusement and recreation, and other advantages of city life. The trend of population from the farms to the towns and villages during the past quarter century has been as notable as the growth of the large cities.

If then a comparison were made between the dwellers on farms and those who are living in either cities or villages, the total population living where they have the advantages of community life would be far greater than the census estimate of nearly 40 million city dwellers.

Rendering Honor to Whom Honor is Due

Washington reports state that a bill is likely to be reported shortly under the provisions of which the thanks of Congress will be tendered to the Army officers who, with Admiral Rousseau of the Corps of Civil Engineers of the Navy, constitute the Isthmian Canal Commission. These officers will also receive promotion with accompanying increase in salary.

No one in the engineering profession, surely, would raise a voice to oppose the giving by the nation of rewards which have been so well earned. But when such honors are bestowed for the success at Panama, ought not due recognition to be given also by Congress to some of the eminent civilian engineers who have carried very large responsibilities in the canal organization? F. S. Williamson, for example, was for a number of years in charge of the entire Pacific division of the canal work, including the Pedro Miguel and Miraflores locks and the sea-level section from Miraflores to deep water in the Pacific. His responsibility at the Pacific end was substantially the same as that borne by Colonel Sibert in connection with the work of the Atlantic division. There is no doubt whatever that Mr. Williamson and his assistants carried out the task assigned them with conspicuous success.

Due credit ought also to be given to a number of other eminent civilian engineers whose services in connection

with the work have been of great importance. Mention might fairly be made, also, of some of the Army officers not connected with the Canal Commission, but whose service in connection with the work in its early stage of development was of great importance in aiding the adoption of proper plans.

A Nation-wide System of Employment Agencies

The United States Commission on Industrial Relations has recently begun hearings in New York upon a proposal to establish a chain of employment agencies in connection with the Federal Department of Labor. The Department would have power to supervise the operations of all private employment offices doing an interstate business and could itself conduct free employment offices where it deemed necessary. The department would also be empowered to supervise, in an advisory way at least, the work of state and municipal employment offices.

The plan which the Commission has outlined and offered for public discussion is the work of W. M. Leiserson, State Superintendent of Employment Offices in Wisconsin, and author of bills recently enacted in the New York legislature establishing similar offices in that state. The agitation of the last few months over the condition of the unemployed in various parts of the country has been responsible for the renewed agitation of the matter of public employment offices.

There is no doubt whatever that a very large part of the buying and selling of labor of all classes, as carried on by the employment offices operated by private enterprise, leaves a great deal to be desired. But it is to be remembered, on the other hand, that the taking over of this business by the city, state or federal government, by no means insures that the work will be efficiently performed. In that, as in any other department of governmental work, only eternal vigilance on the part of the public will prevent the work from being gradually permeated by dry rot, and eventually by graft and corruption.

Without doubt, anything which promises to put the buying and selling of labor, the most important of all commodities, on a better business basis deserves careful attention. The idea that will occur to most business men, however, is that under present conditions the greatest need of all is a revival of business that will create a greater demand for labor.

A Plan to Make Sewer Laterals Water-Tight

The paper by Mr. E. J. Fort, Chief Engineer of the Brooklyn Bureau of Sewers, published in our issue of May 7, describing plans adopted for making sewers water-tight, is of great interest to all engineers engaged in sewerage work. In a large proportion of sewerage systems, the necessity of some method of sewage treatment before final disposal makes the exclusion of ground water from the system a matter of great importance.

Probably the largest contribution of ground water to the average sewerage system comes not from the street sewers but from the laterals on private property, whose aggregate length is usually much greater than the mileage of the sewers in the streets. By any specifications and method of inspection yet devised, it is difficult and probably impossible to insure that these lateral drains from the house to the street sewer shall be laid in such a manner that they will be and will remain water-tight. These house connections are usually laid by local plumbers, employing cheap labor; and whether the pipe joints are well filled with cement-paste or not depends upon the conscientiousness of the man who does the work. The inspector, be he ever so faithful, cannot possibly tell whether each and every joint of the pipe is filled solidly at the bottom. Experience indicates that there is a large percentage of poor joints in the average sewer-pipe job even when it is performed under the best conditions.

The results of these leaky joints are not alone the infiltration of ground water, which results in a largely increased cost in taking care of the volume of sewage, but also (what appeals much more directly to the average property owner) the entrance of tree roots to the drain, which eventually produce stoppage.

We wish to suggest a plan by which these troubles may, it seems to us, be obviated and at a cost little if any greater than that involved in laying pipe in the present manner. Our suggestion is merely that such pipes should be solidly embedded in concrete. This would have seemed doubtless an extravagant proposition a score of years ago when cement was costly and concrete was a thing to be used only in certain special locations. Under the present conditions, however, computations indicate that such a concrete layer around the pipe could be placed at a cost little if any greater than the amount now expended in attempting to cement the joints and to inspect them afterwards.

Take, for example, a lateral house drain made of vitrified pipe 4 in. in outside diameter. Suppose the pipe as laid in the trench is raised two inches above the trench bottom by supporting it on pieces of half bricks. On each side of the pipe is set a board 8 in. in width. Light stakes are driven in the trench bottom to keep the boards in place. Then fill in around the pipe with concrete of rather wet consistency, made with gravel or a small aggregate, filling it up level with the top of the board and smoothing it off. We have then a continuous line of concrete 8 in. square with a vitrified pipe duct extending through its center. The net cross-section of the concrete would be approximately 52 sq.in. It would require, therefore, 36 cu.ft. of concrete per 100-ft. length of sewer. Assume the cost of the concrete for materials, mixing and laying at $5 per cu.yd. (which is not far from the cost at which it is often laid on sidewalk contracts). Then the total cost per lineal foot of this concrete jacket surrounding the vitrified pipe would be 6⅔c. Of course, these figures would vary according to local conditions. A smaller section of concrete could be adopted in some cases and under favorable conditions it might be placed at a lower cost per cubic yard.

It may be objected that the concrete would not flow in around the under side of the pipe to fill it solidly. To meet this, the operation above suggested could be improved upon by laying a couple of inches depth of concrete on the trench bottom between the boards first, then embedding the pipes in this.

Probably most engineers would prefer to follow precedent and fill the pipe joint with cement mortar as well

as embed it in concrete. It is doubtful, however, whether there would be enough gain in this to be worth the added cost. The wet concrete would flow into the joint more or less anyway. Further, if the joints were not filled, the trouble with ribs of hard mortar projecting inside the pipe and interfering with flow through it would be obviated.

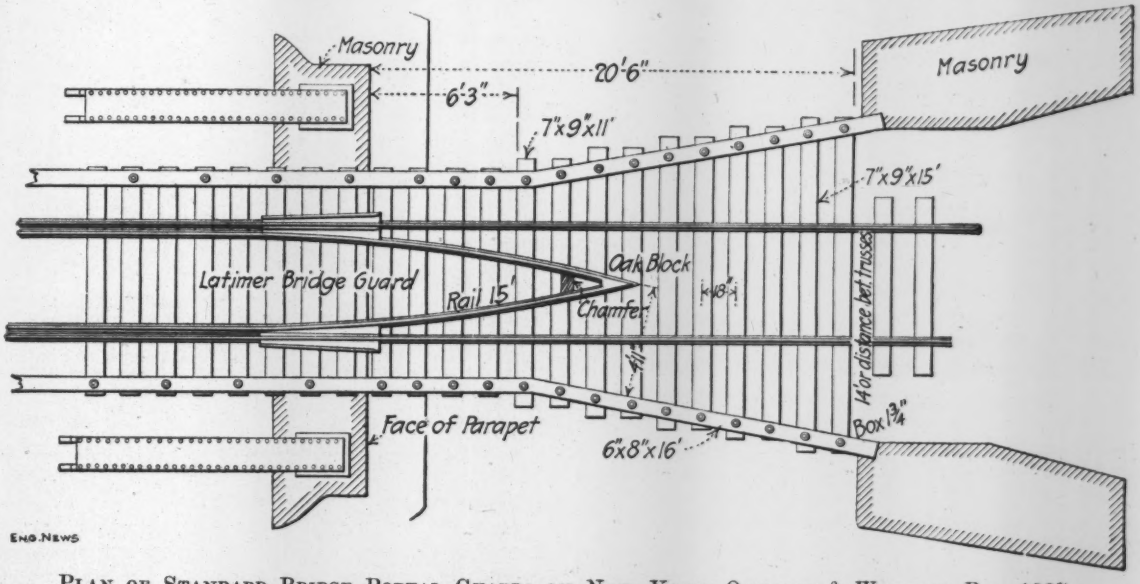
Possibly some of the readers of ENGINEERING NEWS may have already tried this plan of laying sewer laterals and if so we shall be pleased to receive the record of their experience. We can well understand that an engineer who should attempt to introduce even so simple an innovation would have to encounter all sorts of opposition from plumbers, property owners and others; but the value of sewer connections which will be water-tight, proof against clogging by the roots and in addition, safe from injury by careless trench diggers should be sufficiently apparent to bring about its use, notwithstanding conservative opposition.

Collision Piers to Protect Bridge Trusses from Derailed Cars

The recent disastrous accident on the Wabash Ry., caused by the striking of a derailed freight-car body against the end post of a bridge truss, calls attention anew to the desirability of safeguarding bridge structures against accidents of this sort. A correspondent raises the question whether a collision strut extending from the end post to a connection with the bottom chord at the first panel-point would have prevented this accident, since the weakening of the end post appears to have been due to its lateral deflection and the punishment it received from the blow, and not to bending in the plane of the truss.

It seems worth while in this connection to call attention to a suggestion made in the columns of ENGINEERING NEWS, more than 25 years ago, at the time of the terrible White River bridge wreck in Vermont. In that wreck, an express train on the Central Vermont R.R. was derailed just before reaching a high bridge. The bridge and train fell into the gorge below and were set on fire by the car stoves. The public agitation following that disaster was chiefly responsible for the introduction of steam car heating and the abolition of the car stove. That disaster, with some other notable railway-bridge accidents which occurred about the same time, was also chiefly responsible for a very general improvement of practice in the construction of railway-bridge floors and guard rails.

In an editorial discussing the White River disaster, the late A. M. Wellington urged the general use of outside guard timbers on railway-bridge floors, extending the full length of the bridge and flaring outward beyond the bridge portal to bring back into line any derailed wheels that might be running on the ties and about to drop off the ends as they reached this point. Mr. Wellington further suggested—and this is the point which seems worth calling special attention to at this time—that at the point where the flaring guard timber ended there should be a heavy oak post 16 in. square and set 8 ft. in the ground with its top 4 ft. above the rail. Such a construction was then standard on bridges of the New York, Ontario & Western Ry., having been designed by the late J. E. Childs, who was their Chief Engineer and General Manager. Regarding this, Mr. Wellington said:



PLAN OF STANDARD BRIDGE PORTAL GUARDS ON NEW YORK, ONTARIO & WESTERN RY., 1887.
(With masonry collision piers added.)

> Should a derailed car be so far out of place as to be entirely uncontrollable [by the flaring guard timbers and guard rails], it will strike against the post, break the coupling and probably be so checked or broken up that none of the wreck will reach or pass the abutment.

In the discussion which followed in the columns of ENGINEERING NEWS, M. J. Butler described the bridge guards used on all bridges of the Ontario & Quebec division of the Canadian Pacific Ry., under P. Alex. Peterson as Chief Engineer. A heavy masonry pier, its top 3 ft. 6 in. above rail level was built directly in front of the bridge end post. In a later issue, J. W. Schaub described a somewhat similar guard pier which was used in

the designs made by C. Shaler Smith, for all his important bridges.

It seems to us that this discussion, published more than a quarter century ago, is well worth calling renewed attention to at this time. To make the suggestion clear we have redrawn from our issue of Feb. 12, 1887, the plan of the standard bridge portal guard of the New York, Ontario & Western R.R., substituting a masonry pier in place of the oak post shown in the original.

Any car body on a derailed truck which is so far out of line that it would strike the truss if allowed to continue and could not be brought back into place by the flaring guard timber, would strike instead this masonry pier and expend its force on that instead of knocking down the bridge. By making the side of the pier flaring as shown, the car body striking it would receive a glancing blow and be thrown toward the center of the track instead of down the bank.

Such collision piers need not be at all expensive. A pier 4 ft. wide, 12 ft. long and 10 ft. total height from foundation to the top would contain about 18 cu.yd. of masonry and would cost, at ordinary contract prices per cubic yard from $50 to $75. By delivering the stone directly on the site from work trains, and using the labor of section gangs to build the piers at times when regular work is slack, the cost of such piers could be kept down to a very low figure.

It seems to us that this discussion of the safeguarding of bridge trusses from collision, carried on by distinguished engineers a quarter century ago, is well worth consideration at the present day by those who are responsible for the safety of important bridges on railways of heavy traffic.

Letters to the Editor

More About Teredo-Proof Wood Piles

Sir—I note with interest a letter from Howard F. Weiss in your issue of Feb. 5 relative to Australian turpentine tree piles. I have had several years' experience in Australasia with wood and reinforced-concrete piling and especially with the ironbark tree piles. The name "turpentine" is not generally used, but engineers invariably speak of and specify this tree as "ironbark," its common name, derived from the fact that the outer annular rings of the turpentine tree (which is, of course, a eucalyptus) are exceedingly dense and hard. The ironbark has practically no bark after being converted into piles and from experience I have found that the bark is not of the slightest use in resisting marine borers.

I have supervised the driving of several thousand of these piles at various places and have seen many more driven and in service, in some cases after 20 years' use in teredo-infested waters. I know personally practically every wharf or pier of importance in New Zealand where ironbark piles have been used, and in not a single instance were the piles driven with the bark on.

The Wellington (N. Z.) Harbor Board has a fine equipment of piers and wharves giving approximately 50,000 ft. of berthage, and in all cases the ironbark piles (two of the wharves being of reinforced concrete) were protected with yellow-metal ship sheathing from the bottom to high-water mark.

The teredo is very active in the warmer parts of Australia, but in the ports to the south, where the water is colder, not much trouble from marine borers is experienced. In Auckland, N. Z., the piers and wharves were originally constructed with ironbark and totara piles, the latter being a native wood similar to cedar, but denser and stronger. Both these woods are much superior to creosoted pine or plain red cypress piles, yet it was thought advisable at Auckland to carry out all new construction in reinforced concrete, owing to the cost of maintenance against the teredo. This port now has very fine concrete wharves, second to none in the world.

Mr. Weiss states that turpentine "is almost too brittle to be used for fender piling." With this I do not agree, as this wood is far from brittle, although its resiliency is practically nil. This, however, is more than compensated for by its very great strength.

The writer designed and erected a reinforced-concrete wharf in New Zealand with ironbark fender piles which were subjected to extremely hard service—the wharf in question lies behind a breakwater partially built and exposed to the heavy seas of the Pacific. I have seen one steamer, of 10,000-tons displacement, lie on the weather side of this wharf during a heavy gale, and the result was but two broken fender piles out of a total of 98 in actual contact with the vessel's side.

As regards top diameter in long sticks; it is quite easy to obtain 60-ft. turpentine piles from 20 in. at the butt to about 12 in. at the top. This, coupled with the fact that turpentine piles withstand driving far more satisfactorily than any pine will, makes the turpentine pile available for any ordinary work.

It would be interesting to know whether there is a timber in existence which, in ability to withstand marine borers and rough usage in driving, and in strength, rivals the turpentine or "ironbark."

F. H. Frankland,
Bridge Engineer, Highway Department.
Calcasieu Parish, La., May 2, 1914.

How the American Society of Civil Engineers is Controlled

Sir—The purpose of the so called Keefer amendment to the constitution of the American Society of Civil Engineers (increasing the number of geographical districts into which the membership is divided, from 7 to 13) was, quoting the explanation by the Secretary, made at the Annual Convention, June, 1913:

that the outlying districts are geographically too large . . . . the representatives from those districts do not represent any special community in some cases . . . . and [by] adding six more districts . . . . each of those members [of the Nominating Committee and of the Board of Direction] will represent more nearly a constituency . . . . in brief . . . . in order to get as nearly as possible the same number of members in each of the several districts.

This is an official admission that the six districts did not contain "as nearly as possible the same number of members."

The tabulation (Table I) of the distribution of membership among the various districts will show quite clearly how inadequately the present districts represent numerical equality in membership.

TABLE I. DISTRIBUTION OF MEMBERSHIP IN THE AMERICAN SOCIETY OF CIVIL ENGINEERS (1913)

Dist. No.	1 Total Corp. and Non-Corp.	2 Non-Corp.	3 Corporate	4 Relative Corp.-Membership
1*	1434*	275*	1159*	168.9
2	927	115	812	118.4
3	804	73	731	106.5
4	1091	126	965	140.7
5	788	102	686	100.0
6	1013	109	904	131.8
7	1232	186	1046	152.5
Total	7289	986	6303	

* Note: All resident members.

At the same time the constitution specifically provides for an automatic adjustment of this inequality without resort to amendment. These provisions are: (1) that the membership in six of the seven prescribed districts (District 1 excepted) shall be as nearly as practicable an equal number; (2) the Board of Direction is given authority to make this equality possible and (3) announcement of this division to secure equality of members must be made each year before Mar. 1 (Art. VII, Sec. 1).

The admission of inequality is officially made, the constitutional provision for correcting it obtains, hence no amendment is necessary. Query—Why were the amendments allowed to go to a vote? Any officer of the Society whose duty is to "manage the affairs of the Society in conformity to the provisions of this constitution" could and should have called the attention to those submitting the amendment to this marching up the hill and marching down again. Think of the time and energy that would have been saved thereby!

As to the assertion that by increasing the number of geographical districts from 7 to 13, the Nominating Committee and the Board of Direction "will represent more nearly a constituency," no argument was presented by those backing this amendment and none was advanced during the discussion thereon to support the assertion. Nor is any possible; the wish is father to the hope.

The defeat of this proposed amendment was a foregone conclusion; the reason or reasons therefore are now apparent. The most apparent is general apathy. Constitutional amendments are obviously not in order until the means at hand are exhausted; not, unless backed up by a sustained demand.

It should also be apparent to anyone that one of the earliest questions to engage the attention of the Board of Direction is to devise some means to interest the members in the affairs of the Society. Only 50% of the membership voted on the recent amendment, in spite of vigorous electioneering! This lack of interest is not due to the unbalanced districts nor could it be cured by a more equal division. On the other hand, it may well be due to one thing that is a frequent complaint, though one never appearing in the *Proceedings* of the Society. That complaint is that District No. 1 ("territory within 50 miles of the post office in the City of New York") has a strangle hold on the Board of Direction.

Let us see what truth there is in this complaint. There are in the Board of Direction 30 members; a constitutional quorum is 5; all the meetings are held in the Society House, except that at the Annual Convention, at which, as also the meeting held at the time of the Annual Meeting, a quorum is 9.

If from the List of Members for 1913, the place of business or residence is taken as indicative of the district represented, the Board stands as shown in Table II.

TABLE II.

District No.	1 — 12	District No.	5 — 4
District No.	2 — 5	District No.	6 — 4
District No.	3 — 0	District No.	7 — 3
District No.	4 — 2	Total	30

And if also this same method is applied to the attendance at the 12 meetings of the Board for the last Society year, it will stand as shown in Table III.

TABLE III.

Districts	1	2	3	4	5	6	7
Attendance	84	25	0	13	7	22	0

In other words, out of a possible attendance of 360, District 1, in 1913, had 84, or 23.3%; out of actual attendance of 151, District 1 had 84 or 55.6%.

Setting down the relative corporate-membership by districts, and against it the relative attendance at Board meetings, there appears Table IV.

TABLE IV.

Districts	1	2	3	4	5	6	7
Relative corp. membership	168.9	118.4	106.5	140.7	100	131.8	152.5
Relative attendance (actual)	1200	357.1	0	185.7	100	314.3	0

May it not be said with a fair degree of accuracy that the complaint of the outlying districts has some material substance?

J. Bodine Wright,
M. Am. Soc. C. E.
301 W. 107th St., New York City, Apr. 8, 1914.

The Efficient Operation of Sewage Treatment Works

Sir—In Engineering News for Apr. 16, I noticed a letter on "European and American Ways of Operating Sewage Treatment Works," which is a subject of more than ordinary interest to me at the present time.

It has not been my pleasure, as yet, to visit the United States of America, and to inspect your most recent works of sewage disposal, therefore, I cannot express any opinion of value on the procedure in the States. As regards this country, I do claim to be in a position to express a very definite opinion owing to my experience in connection with some of the most extensive plants in England.

Many grievous mistakes have been made in the past, and, sad to say, are still being made, and were it not for the government legislation and the strict supervision of rivers boards there can be but little doubt that the tendency would be for local authorities to display a certain amount of apathy in the direction of caring for the public health of the community. I do not mean to suggest that such apathy would be willful, rather would it be due to an utter lack of appreciation of the seriousness of the question at issue.

It may be that in America there is no Government Department corresponding to our Local Government Board, or rivers boards, legally constituted with authority over large watersheds. It might be suggested that no great improvement can be effected until such authorities are empowered to exercise control over large watersheds and to compel cities and towns to construct and *efficiently operate works for the disposal of sewage on strictly scientific lines.*

In order to operate works on these lines, adequate supervision is absolutely necessary and in the long run will prove most economical. It is no exaggeration to say that the greater percentage of modern sewage-disposal works fail, or partly fail, owing to lack of proper supervision and control.

Numerous instances could be cited where modern sewage-disposal works are operated by unskilled workmen, year after year, without a single chemical analysis being taken, with the result that in course of time additional works have to be constructed owing to bad effluents being constantly discharged into the rivers, whereas by the expenditure of a comparatively small sum per annum on chemical supervision, such capital expenditure would be unnecessary. This "penny wise and pound foolish" policy, short sighted as it is, is probably due to a complete misunderstanding of the problem, and the remedy lies with the state, for apparently it is hopeless to look to the individual for any improvement, save in a few isolated exceptions which only tend to prove the rule.

I may perhaps mention a case, one of the largest sewage-purification works in the world, i.e., that of Davyhulme, where practically the whole of the sewage of the city of Manchester receives treatment—the engineering of which works I have the honor to hold.

It may be stated emphatically that these extensive works could not remain in efficient operation were it not for a highly scientific staff of trained chemists and bacteriologists, under the control of Dr. Gilbert J. Fowler, whose name is well known in the States, and also an experienced staff of skilled mechanics and trained workmen and clerks and an energetic works manager.

I have come to the conclusion, after most careful consideration in the light of recent developments on sewage purification, that if a sewage works is to operate to the best advantage, the hearty and sincere coöperation of the chemist, engineer and works manager, in control of their respective departments, is absolutely essential to the well being of the said works.

In the first place, it must be suggested that once a sewage works is placed in operation, the duties of the engineer appear to be of minor importance, save when he is called in to offer advice when occasion arises.

The works then rely upon the chemist and works manager for efficient operation.

In most sewage-disposal works, the operations consist of the following sections:

1. Removal of heavy suspended solids and floating garbage from the sewage.
2. Reduction of finer suspended solids in tanks.
3. Oxidation in filters.
4. Removal of so called humus in the final effluent.

Taking the above sections seriatim, Nos. 1 and 2 are conditioned almost entirely by the velocity at which the sewage flows through the tanks, and in order to ascertain whether the tanks are operating efficiently, analyses of the crude sewage and effluent should be taken at definite hours of the day.

The works manager has also to preserve as uniform a velocity as possible in each tank, in order that the settlement required is obtained.

The efficient operation of No. 3 necessitates the careful analysis of samples of the sewage entering and leaving the filters, so as to ascertain whether or not the filters are becoming overworked and losing their capacity.

No. 4 also requires careful observations being taken of the percentage of suspended solids in the final effluent.

It will readily be seen, therefore, that if there are no means for carefully examining the sewage flow through a works and compiling data obtained from day to day, the operation of a sewage works—which is in reality very delicate and unable to withstand rough usage—must be by rule of thumb, and the results obtained will be in most cases a fitting reward to those responsible for such a short-sighted and negligent policy.

The Manchester Corporation Rivers Committee is to be commended for the splendid facilities which they have placed at the disposal of their chemist for research work. Manchester may not have benefited as much as she deserves, so far, by what she has done, but it can at least be said that the whole civilized world has received considerable help and guidance from what has been brought to light in the laboratories at Davyhulme.

Oswald J. Wilkinson,
Engineer of the Manchester Corporation Rivers Committee for the Davyhulme Works Extension Scheme.
196 Deansgate, Manchester, England, May 1, 1914.

The Chicago Water-Works System

Sir—I was much surprised to see in your issue of Apr. 23, the article on "Needed Improvements in the Water-Works System of Chicago," by W. D. Barber, Assistant Engineer, Bureau of Engineering, as it contains many misstatements.

It is stated, among other things: "Another great defect in the Chicago water system is that the intake ports of the cribs are so constructed that the water is drawn directly from the surface rather than from the bottom of the lake."

With the exception of the old Chicago Ave. crib, built in 1865, all the water-works intakes of Chicago have their intake ports located a few feet above the bottom, or as near the bottom of the lake as is practicable.

There are no radical changes in either the distribution system or the tunnel intakes contemplated that are a departure from the policy adopted many years ago and which has since been followed, and which Mr. Barber in his article seems to bring out as a new idea. From my report on the "Water Supply System of Chicago," published in 1905 and widely distributed, the following is quoted (from p. 16):

The Development of the System of Water Mains—From the time when the Chicago Hydraulic Co., in 1840, commenced the laying of a mile or two of bored-out logs, serving as their water mains, the pipe system has had a similar gradual development to the pumping plants. The original town and city of Chicago laid only such pipes as were necessary for the immediate future. The various towns and cities, with their respective water-supply systems, and afterward annexed to the city, had done the same. Shortsightedness and

probably the state of finances prevented any other course. Each system was added to gradually, without any thought whatever being given to a possible amalgamation of the various systems.

Within the space of a few years' time all these plants and systems were voted as part of the city of Chicago, and instead of one intelligently laid out and developed system, the city had on its hands a number of these independent systems. Each part of the greater Chicago grew rapidly in population and manufacturing establishments. The City Engineer, who was placed in charge of all these plants, had numerous other duties. New additions had to be planned and executed continuously. The water fund was diverted for all kinds of purposes. Is it any wonder if the now greatest system of water-works in the world is not an ideal one?

The locations of the pumping stations, several of which are situated on the eastern boundary of the city, on Lake Michigan, would, of course, have been different had this vast system been planned all at once. Likewise the pipe system. The invariably underestimated growth of the city, in both area and population; the feverish haste with which additions had to be planned and executed in order to meet the constantly growing demands, the defects in organization of the municipal departments, the uncertainty of the future trend of increases in population and manufacturing centers, made it well nigh impossible and beyond human intelligence to plan an ideal system for a metropolis of many millions of people. Even had such a system been planned from the beginning, its execution would have been utterly impracticable from a financial point of view.

And on p. 40 I stated:

For densely populated and level districts it will be found more economical to have pumping stations a few miles apart than to have large units supplying greater areas.

Ever since I became connected with the water-works development of Chicago, I have advocated and carried out the very principles that Mr. Barber brings out as something new, except as to his limiting the capacity of each station to about 50,000,000 gal. per 24 hr., which if carried out would at this time require between 20 and 30 stations, as against our present 10 or 15.

Anyone who has given the subject some study knows that there is an economical limit as to the capacity and distribution of pumping stations in a large city, and the problem must be given careful consideration for each particular case. I believe that the relation of the number, location and capacity of pumping stations to the main distribution system (if we except stations located along the shore early in the history of Chicago) approaches as nearly to the economical limit as the conditions would warrant. All our pumping stations for years past and all our contemplated new stations are placed inland and supplied by gravity tunnels, a thorough study of the situation being made in each case.

There is much more that could be said with reference to the article in question, but I believe that what has been said is sufficient.

JOHN ERICSON, City Engineer.

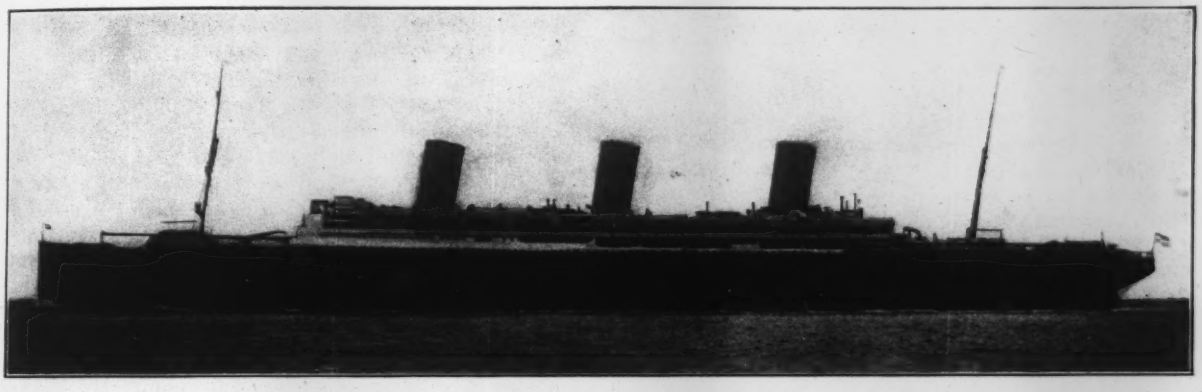
City Hall, Chicago, May 4, 1914.

NOTES AND QUERIES

H. L., Norwood, Ohio, writes: "Do any of the readers of "Engineering News" know of a device whereby on a railway curve which intersects another track, the outer rail may be given superelevation in the usual manner so that trains may run over it at high speeds?"

The Largest Vessel Afloat; May, 1914

The Hamburg-American liner "Vaterland," the largest vessel afloat or projected, left Hamburg on her maiden voyage on May 14 and reached New York on May 21. The "Vaterland" is 950 ft. long, 100 ft. in beam and has a tonnage of 58,000. On account of the 100-ft. beam, she possesses the unique inability of passing through the Panama locks, which are 1000x100 ft. in plan.



HAMBURG-AMERICAN LINER "VATERLAND"; THE ONLY SHIP THAT CANNOT GO THROUGH THE PANAMA CANAL

The construction of the vessel was commenced in September, 1911, in the yards of Blohm and Voss, Hamburg, and was launched Apr. 3, 1913. She has a double bottom and a double skin extending well above the water line. Her hull is divided by both longitudinal and transverse bulkheads and particular attention has been paid to the fireproofing of the structure as well as the fire-protection of the entire vessel. There are life-boats capable of carrying the entire ship's company, a possible maximum 5300 persons. Frohm anti-rolling tanks have been added to her equipment.

The ship is driven by four screw-propellers, geared to four steam turbines. Her trial-trip speed was 26.3 knots, but it is not intended to enter her for the transatlantic record. Together with the slightly smaller "Imperator," until now the record-size ship, the "Vaterland" will be used by the Hamburg-American line for its highest class transatlantic express service.

Increased Use of Asphalt in the United States is shown by the annual report of the General Asphalt Co. for the year ending Apr. 30, 1914. The total amount of asphalt sold by the company last year, including both Trinidad and Bermudez asphalt, and Trinidad liquid asphalt, was 321,222 tons. In 1909 the total sales were only 192,644 tons.

San Fernando Inverted Siphon, Los Angeles Water-Supply

By Burt A. Heinly*

SYNOPSIS—Describes the design and construction of 12 miles of 72- to 62-in. riveted-steel siphon forming a part of the City Trunk Line from the lower end of the Los Angeles Aqueduct to the city of Los Angeles. The siphon has a maximum working head of 260 ft. and a maximum carrying capacity (above the first branch) of 150,000,000 gal. a day.

On Apr. 27, began the testing of the San Fernando steel inverted siphon, the most important section of the City Trunk Line, the especial function of which is to convey a supply of domestic water from the outlet of the Los Angeles Aqueduct into the City of Los Angeles. The initial operation of the siphon makes possible the turning of a portion of the aqueduct's flow into the Los Angeles River by which means the municipality, through this short cut, on or about May 2, received into its distribution mains the first of the Owens River supply for which it has expended in excess of $25,000,000 and nearly a decade of onerous work on the part of its servants.

The completion of the siphon across the San Fernando Valley under satisfactory conditions offers opportunity for a description of the methods and materials by which this important section of the work begun in August, 1912, was made ready for operation. The expenditure for this large siphon work alone approximates $675,000.

In explanation, it should be stated that the mouth of the aqueduct lies 25 miles in a bee-line to the northwest of Los Angeles and the City Trunk Line, as it is called, is the first of the several proposed lines of distribution which has been placed under construction. For this line, comprising 26 miles of open and closed conduits, tunnels, reservoirs and pipe lines, $1,500,000 was voted at a general election held Apr. 19, 1913. The work was in progress before this time with funds from the revenues of the water department. It is expected that aqueduct water will be delivered into Los Angeles through the full length of 26 miles about the last of May or the middle of June. In length, this one siphon exceeds the aggregate length of all the steel siphons of the aqueduct, although it is of smaller diameter. Its office is to deliver water from the gate tower of the Lower San Fernando Dam (three miles below the outlet of the aqueduct) to the north portal of the Franklin Tunnel, where the City Trunk Line pierces the crest of the Santa Monica mountain range. Including the 540 ft. of 72-in. concrete pipe through the Lower San Fernando Dam, the total length of the siphon is 63,867 ft. or a little over 12 miles. The diameter ranges from 72 to 62 in. Its inlet elevation at the Lower San Fernando gate tower is 1075 ft. above sea level with the hydraulic grade at 1134 ft. At its lowest point, where it crosses the Los Angeles River, the elevation is 615 ft. and its outlet in the Franklin tunnel is at Elev. 854 ft. The maximum working head is 260 ft.

Primarily, the siphon, as a part of the City Trunk Line, is designed to convey water into the City but its office in reality is much broader than this.

*Department of Public Service, 645 Olive St., Los Angeles, Calif.

Design of the Siphon

In designing the City Trunk Line, the San Fernando siphon was figured at its inlet for a capacity of 11,500 miner's inches. Of this, 2000 miner's inches, or 26,000,000 gal. daily, was assigned as a full allotment to Los Angeles City which, with the present supply of 55,000,000 gal. from the Los Angeles River, it is estimated, will provide a sufficient supply for the city within its present limits; 2000 miner's inches was assigned as a half supply to the Cahuenga District, that region lying to the southwest of Los Angeles, sloping from the Santa Monica mountains to the sea and now being laid out in large villa estates; 1000 miner's inches was assigned to the Inglewood district, lying to the south of Los Angeles and being built up with small homes; 1100 miner's inches was assigned to the Glendale District for the communities of Burbank, Glendale, Tropico, Eagle Rock, South Pasadena and Bairdstown, lying to the northwest, north and northeast of Los Angeles, and 1575 miner's inches was assigned to the Providencia District as a half supply to that territory lying on either side of the San Fernando siphon. The full supply was figured at 1 in. to 7½ acres and the half-supply at 1 in. to 15 acres. (See Eng. News, Dec. 29, 1910, for explanation of method of assignment.) Where half-supply is assigned, the country is sparsely settled and it is assumed that, when the time demands, duplicate lines can be run with economic saving over expenditures for full supply at this time. These assignments make provision for 7675 miner's inches average flow. Approximately 50% excess was then added to provide for peak-load consumption during the hot summer dry months of this region, bringing the capacity of the siphon to 11,500 miner's inches at the inlet, or in round numbers 150,000,000 gal. in 24 hr. As diversions are made, the diameter of the siphon is proportionately decreased until at the outlet the capacity is 7500 miner's inches. By shutting all the outlet gates of the siphon, however, this may be increased to an average flow of about 9000 miner's inches.

The first 31,523 ft. to the diversion for the Glendale District is of 72-in. diameter, with a gradual reduction to 62 in. in diameter, as shown on the profile.

The siphon carries the high velocity of an average of 8 ft. per sec., due to the steep hydraulic slope of 4 ft. to 1000. The line is not designed for full static pressure for reasons of expense, but is constructed for full pressure up to the maximum hydraulic grade line with a factor of safety of four, or 15,000 lb. per sq.in. maximum pressure on a net section.

Concrete Approach

Before entering upon a detailed description of the steelwork, with which this article is mainly concerned, brief reference will be made to the 540 ft. of concrete pipe carrying the flow from the gate tower through the dam

of the Lower San Fernando Reservoir. The slope is here 0.5%. With an inside diameter of 72 in., the thickness of the concrete at top and bottom is 12 in. with 18 in. at the spring line. A 1:5½ mix was used, the gravel being well washed.

The reinforcement varied. Beginning at the tower, the transverse reinforcing consisted of ¾-in. round iron rods spaced 6 in. c. to c., this interval being gradually increased to 9½ in. at a distance of 130 ft. For the next 100 ft., where the pipe will underlie the dam, the spacing was 10 in. c. to c. on account of the deeper covering; then beginning at 9½, the spacing was gradually reduced to 6 in. at the point of entry from the dam and the union with the steel pipe. The longitudinal reinforcing consisted of ⅜-in. round iron spaced 2 ft. c. to c.

Starting from a point 15 ft. from the end of the steel pipe, the concrete pipe was gradually increased in thickness and extended so as to embed the steel pipe for a distance of 8 ft. in a poured heavy mass concrete anchorage block 2 ft. thick on all sides. This serves to hold the steel pipe securely in place and is heavily reinforced transversely by ¾-in. twisted iron rods, 6 in. c. to c., and longitudinally by rods of the same diameter, 18 in. c. to c. At the middle point of the anchorage, an old 6x½-in. double-ply rubber belt was wrapped once around the pipe so as to prevent any possible leakage in case the bonding should break. Up to within 18 in. of the end of the steel pipe, the concrete anchorage forms a perfectly flush joint with the steel but from there on the steel pipe tapers so that at its end there is a 1½-in. space between steel and concrete. This space was formed with wooden wedges put in dry, which have been left in place to form a perfectly tight joint. Should leakage ever occur, they can be removed if necessary and the joint calked and grouted with cement.

At the outlet, as soon as the pipe has been given time to assume permanent position, the transition to tunnel will be handled in a similar manner.

Steel

The siphon is of single sheet construction. Steel for plates and rivets was all made by the basic openhearth process. The lengths, diameters, thicknesses and riveting are shown in the accompanying table:

Length, ft.	Diameter, in.	Thickness, in.	Longitudinal riveting
19,200.55	72	¼	Double
5,710.00	72	¼	Triple
6,612.49	72	5/16	Triple
1,524.10	68	5/16	Triple
1,904.09	66	5/16	Triple
14,000.89	66	⅜	Triple
9,799.88	64	⅜	Triple
1,870.81	62	5/16	Triple
2,704.38	62	¼	Double
63,327.19			

Transitions are included in the above. All circumferential seams were single riveted.

Bids for the pipe (about 8260 tons) were opened by the Board of Public Service Commissioners, Oct. 25, 1912. Bidders were given the alternative of submitting proposals on either the plates fabricated at the shop or on the pipe in 24-ft. sections, delivered at the side of the trench.

To accelerate the work and provide for early delivery of the material, the contract was divided. The Riter Conley Co., of Pittsburgh, Penn., was awarded the contract for fabricated material for all the 68-, 66- and 64-in. pipe, with rivets, an estimated 4249 tons delivered at Leetsdale, Penn., for $141,065. To the Lacy Manufacturing Co., of Los Angeles, was awarded the contract for all the 72- and 62-in. pipe in 24-ft. sections, with rivets for circular round seams delivered at the trench—an estimated tonnage of 4011 tons at a price of $281,70[illegible].

The Riter Conley Co. delivered the plates at its factory, rolled to true cylinders while cold, beveled for outside calking, sheared and punched, and with the edges of the longitudinal seams where they project under the round seams carefully scarfed. The plates were then nested on flat cars and shipped in carloads of from 40,000 to 60,000 lb.

The Lacy Co. delivered the plates on the ground, as already stated, where they were riveted by that company into four-ring sections, painted and turned over to the construction force of the city.

The pipe line is built of lap joints with alternate inside and outside sections, the ¼- and 5/16-in. plate being 5 ft. 9⅞ in. and the ⅜-in. plate being 5 ft. 9¾ in. long.

The Hartford Boiler Standard specifications for riveting were employed, with the efficiency of the joints ranging from 72 to 80%. All rivets were cone headed and of full diameter; ⅝-in. rivets being used on the ¼-in. and 5/16-in. plate, with 11/16-in. open holes, and ¾-in. rivets for the ⅜-in. plate, with 13/16-in. open holes.

Field Construction

As in the construction of the aqueduct, all the work was performed by day labor under the direction of the city's engineers.

Upon the arrival of the steel, it was unloaded at two railroad sidings, best located geographically for reduction of haul, and from these points was loaded in nests of two rings, 6 rings to the load, and hauled by four-mule team to the line of the survey. The average haul was approximately three miles, with a cost of 25c. per ton-mile.

Two camps were established; one at the intake of the siphon and the other midway between the two ends, each under the direction of a field superintendent and both camps working southward. These camps, each prepared to accommodate up to 225 men, were conducted by the city which furnished well made bunk houses, and excellent meals at 25c. each. (See Fig. 1 for view of typical camp, p. 1146.)

The excavation was performed by two Model 40 Marion steam shovels, equipped with standard jacks and extra long booms 25 ft. in length (Fig. 2). The dippers used were of ¾-cu.yd. and 1¼-cu.yd. capacity.

The depth of the trench ran about 9 ft., or sufficient to give a covering to the pipe of from 3 to 4 ft. The trench was as narrow as the shovel could dig, varying from 9 to 11 ft. The soil was of a sandy character, which made easy excavation, the progress varying from 125 to 225 lin.ft. per day. No cribbing was found necessary and although there were frequent cave-ins, they were not of a serious character. In one stretch of 1800 ft., where the soil was firm, the depth of cut extended to 23 ft. Here the shovel dumped the spoil at the side of the trench where it was carried back out of the way by two-horse scrapers. Cost of trenching averaged from 25 to 30c. per lin.ft. Backfilling was done with teams and Fresno scrapers, each gang on an average doing 150 ft. per day. This cost averaged about 18c. per ft.

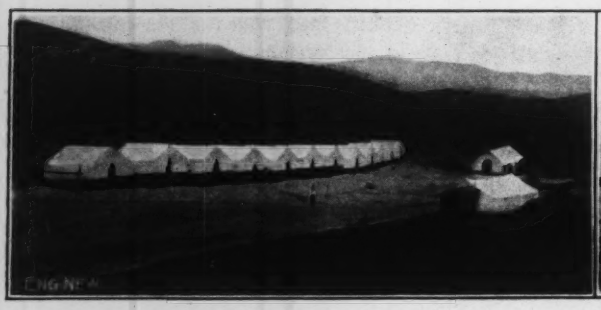


FIG. 1. TYPICAL CAMP RUN BY THE CITY OF LOS ANGELES ON SIPHON CONSTRUCTION FOR WATER-SUPPLY

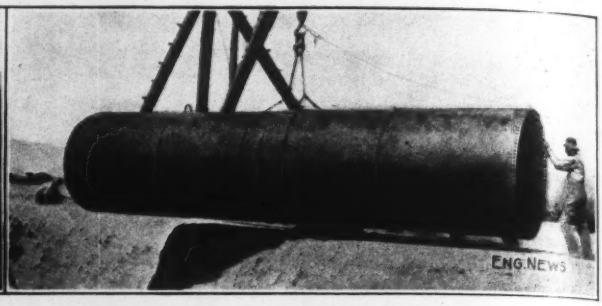


FIG. 3. A FOUR-RING SECTION OR "TANK" ON THE EDGE OF THE DITCH OF THE SAN FERNANDO SIPHON

The air equipment consisted of one Clayton, two-stage, tandem air compressor of a capacity of 200 cu.ft. of free air per minute delivered under 100 lb. pressure, situated at the intake end of the siphon; one two-stage Ingersoll-Rand, of a capacity of 700 cu.ft. of free air per minute, delivered under 100 lb. pressure, situated at the Midway camp and a third compressor of the same make and capacity placed about 4000 ft. from the outlet. The Clayton was driven by a 75-hp. motor and the Ingersoll-Rands by 100-hp. motors, the generating current being supplied from the transmission lines of the Edison Co. The Lacy Co. for a while operated a gas-engine compressor on its work but later purchased air from the city on a *pro rata* basis.

Of the city compressors, only two were in use simultaneously, for the inlet camp, on moving to the center of the Lacy job, discontinued use of air from the Clayton and took its supply from the Midway Ingersoll-Rand compressor, three miles away, whereupon the Midway camp moved south and took its supply from the Ingersoll-Rand near the outlet. Air was supplied from the Clayton through three miles of 2-in. standard-screw black pipe. From the compressor at Midway, air was served south through 26,000 ft. of 4-in. standard-screw as far as the Los Angeles River. From here, a 2-in. black screw pipe was carried on to the outlet, a distance of 1½ miles and operated from the outlet compressor camp.

RIVETING

On the Lacy job, it will be sufficient to dismiss the description with the statement that the 24-ft., or four-ring, sections were riveted in the trench under the same general plan as that described in the following for the Riter-Conley steel.

The steel from this company, it will be remembered, was delivered in the finished plate. On the fabrication of the pipe from one to three riveting gangs were kept constantly at work under the direction of a riveting foreman. Each gang consisted of one driver at $3.50; one heater at $3; one calker at $4; one bucker-up at $2.75;

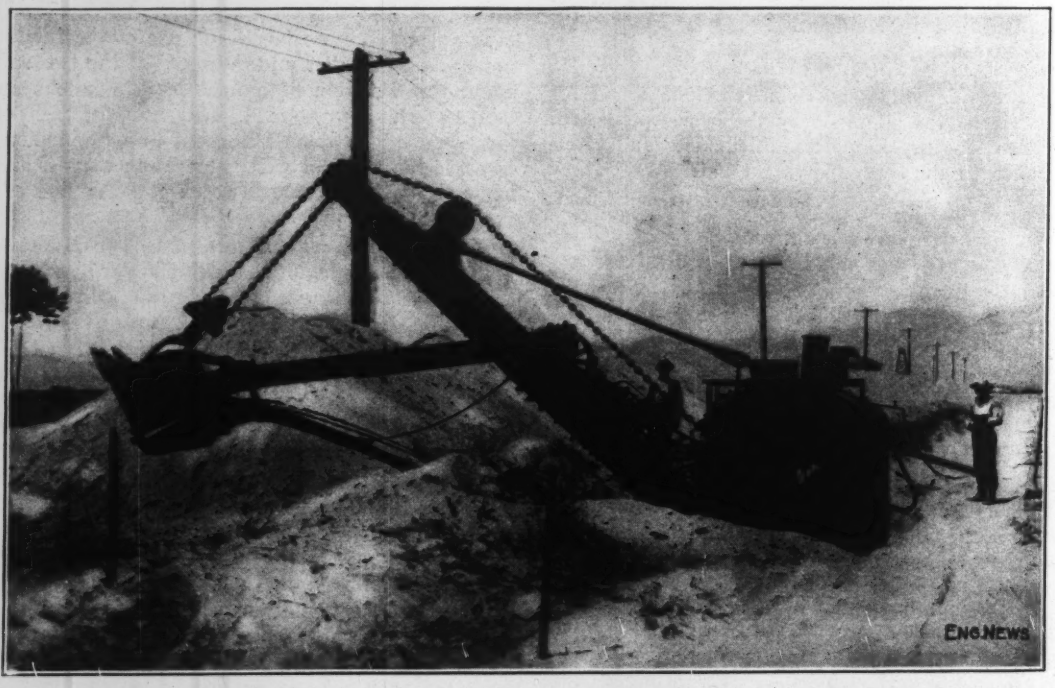


FIG. 2. STEAM SHOVEL WITH 25-FT. BOOM USED FOR TRENCH EXCAVATION, SAN FERNANDO SIPHON

and one sticker at $2.50, for an 8-hr. day. Sometimes, a passer and a helper at $2.50 per day were used on the outside. The riveting crew was capable of laying from 150 to 175 ft. of completed pipe in the trench per day and was nearly always directly in the rear of the shovel.

The regulation riveting tools were used with the exception of the hold-ons which were built on the ground. These consisted of 3-in. galvanized pipe, 12 in. in length, or a little longer than the manufactured article, in order to get a longer stroke, fitted with a piston plunger and a gasket. In calking, a fuller tool was used to drive the metal down to the sheet and then a square tool to drive it in. This gives a much more satisfactory job than where only the fuller is used.

went to the driver, 30% to the heater, 20% to the bucker-up and 20% to the sticker. Upon a hammer test showing any vibration of a rivet, it was marked by the inspector, taken out and replaced on the time of the rivet gang. While the men were paid monthly, the bonus period was marked up every ten days. Men on the job for less than a ten-day period received no bonus, except that if a man were taken sick or injured through a condition of the work, if he was transferred to another gang or other work, or if there were interruptions or stoppage of power, material shortage or causes for which he was not responsible. In such cases, the bonus was paid on a *pro rata* basis. The bonus system brought the best out that was in the men; kept this undependable class of

FIG. 4. STIFF-LEG A-FRAME DERRICK ON WHEELS AND MOVABLE RAILS LOWERING FOUR-RING SECTION OF SAN FERNANDO SIPHON

The plates were riveted into four-ring sections or "tanks" on the side of the trench (Fig. 3). This was found to be about as long a section as could be handled conveniently. It balanced handily, the long seams were easy to get at and the sections could be rolled as the work on the round seams progressed. By riveting the metal into "tanks" on the trench side, the digging of bell holes was greatly reduced. One gang would rivet together on an average of from 12 to 15 rings per day. In the trench, the average day's work was seven round seams. All rivets were driven from the outside of the pipe.

BONUS SYSTEM

As on the aqueduct, the bonus system for riveting was employed. This amounted to $1.75 per 100 for all over 400 rivets driven in an eight-hour day. Of this, 30%

labor close on the job and good workmen constantly seeking their places. Moreover, the men themselves weeded out those in the gang who could not or would not hold to the pace and considerable rivalry was excited between the gangs for the largest and cleanest work done. The largest number of rivets driven in a single day by one man was 1800 five-eighth-in. rivets. This was at trench side under favorable conditions. The average ranged around 1200 rivets in 8 hours.

The sections were hoisted into the trench by means of an 8-ton stiff-leg A-frame derrick (Figs. 3 and 4) mounted on wheels and running on a movable track, and were there bolted up, the bolting-up gang being able to do as high as 400 to 600 ft. per day. The pipe was laid with the longitudinal seams upward (Fig. 5), it being found on aqueduct work that most of the leaks occurred

where the three seams come together. In the trench riveting, the rivets were heated on the outside and put through "drop-holes"—a 1½-in. hole through the top, which was afterward filled up by a riveter who used a little hand forge.

There are both horizontal and vertical angles in the pipe but for these no special construction was required. On curves where the radius was as large or larger than a 6° railroad curve, the pipe was manipulated in the trench to the desired degree with a little reaming of the rivet holes. Other angles were made in local shops and fitted into the places assigned them.

Painting

Water-gas and coal-gas tars were the preservatives employed in painting. The choice of this material was made

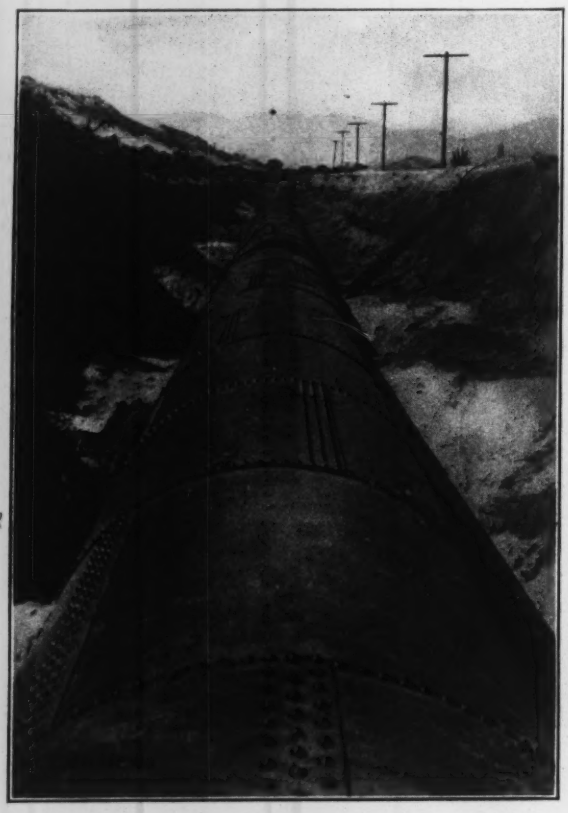


Fig. 5. Riveting System, San Fernando Siphon

in the belief that it is the cheapest and best material to be had. In the use of water-gas tar it was found that this covering successfully attacked rust and even mill scale, that it hung well and that chipping to reach clean metal was unnecessary. This tar is the residue of crude oil used in the manufacture of water-gas, the lampblack being heated to incandescency to decompose the steam. It was purchased from the Denver Electric Co. in carload lots at a price of 7 and 8c. per gal. and cost laid down not to exceed 11c. per gal. The coal tar, which is of much heavier body than the water-gas tar, was purchased in Los Angeles at 10c. per gal. in carload lots, being imported here usually from England, whence it comes as ballast.

One gallon of tar covered approximately 200 sq.ft., depending somewhat on the condition of the weather. One coat of water-gas tar and then two coats of coal-tar were applied inside and outside. The application was made with No. 4 Knot Adams roof paint brushes, which were found by experience to be best suited to this work. One man at $2.25 per day under ordinary conditions would give one coat to three "tanks" inside and out in an eight-hour day.

The tar was usually applied cold, excepting on cool days, when some little heating was necessary, and the applications, again depending on the weather, could follow one another from 24 to 36 hr. apart. All painting was done at the side of the ditch and the pipe on being riveted in the trench was then gone over again at the round seams and at points where rough handling had brought abrasions.

Below the dam of the Lower San Fernando Reservoir, it was necessary to carry the pipe for a distance of 1608 ft. on concrete piers ranging from 1 to 15 ft. above the surface of the ground. These are 68 in number and are spaced under every second outside ring or about 24 ft. c. to c., each being carried to firm foundation. They are 7 ft. in breadth, 18 in. in width and are vertical all around with the exception of the four larger ones, which are built on a 1 to 12 slope.

Also, it was necessary to cross under the tracks of the Pacific Electric Railway at two points. One of these crossings was under a trestle in the Tejunga Wash, where no trouble was experienced, but at the other, for an underground crossing for the 72-in. pipe about 1½ miles from the dam, serious delay resulted. By a decision of an engineering arbitration board the city recently received $42,500 as damages for the injuries sustained from electrolysis of a 42-36-in. pipe line. The railway company was therefore resolved that it would permit no crossing of such a valuable pipe line unless the company were completely absolved from all damages which might result from stray currents. After negotiations, the city agreed to lay the line across the right-of-way, taking such precautions as the company's engineers might request, liability for damages from electrolysis to be determined at the time they occurred, if ever. This construction is a concrete culvert or conduit, the pipe being off the bottom of the conduit, supported on concrete piers. For a distance of 100 ft. on each side of the center line of the right-of-way, the pipe is securely wrapped in a double thickness of tarred paper to which a coating of hot asphaltum has been applied.

At the Los Angeles River, the siphon is carried across the stream on two reinforced-concrete piers, 7x11 ft. at the foundation base, 23 ft. high, with cutwaters upstream and down.

Gates, Manholes and Other Structures

All the gates used were of the Rensselaer make, double-disk, single-gear type, equipped with heavy bevel gear and pinions, and bronze trimmed throughout. Where intended for purposes of regulation, as there is plenty of head, they were designed for the nearest commercial size larger than one-half the diameter of the pipe.

Four miles from the intake, a 54-in. shutoff gate with a 12-in. bypass is placed and then at intervals of approximately three miles, three 48-in. shutoff gates with 8-in. bypasses are installed. These are designed for working

pressures from 150 to 225 lb. (tested to double their working requirement), depending upon their location, and are all hand operated. They are designed to shut off any section of the siphon on which a mishap may occur, or where cleaning may be necessary.

At the Los Angeles River, two 8-in. blowoff valves are situated half way above the bottom of the pipe, and if required can deliver a copious flow into the river channel to have it taken up by the city's present pumping stations a few miles below. In addition, a 6-in. drain valve is located in the bottom of the pipe. At this point, about 3500 miner's inches could be safely diverted into the river under present conditions.

In the Providencia District, the supply for the present will be almost exclusively for irrigation. At distances of every one-half mile, 6-in. high-pressure gate valves are installed. From these, laterals of 8 in. or larger, tapering according to consumption, will be run off at right angles for a distance of from 1½ to 2 miles. Ultimately, as the region develops, these mains will serve the office of laterals for domestic supply.

Approximately every half-mile, manholes with reinforced manhole plates were placed and on the low sides of the shutoff gates, 10-in. saddles were constructed to provide for air valves in case of emergency.

The almost unprecedented rains of late January and February, 1914, brought great inconvenience and delay to the work as it was being carried on in the Pacoima and Tejunga washes at the time. It was not possible to fill the pipe as it was constructed and at two points it floated but with no important financial damage.

The work was done under the personal supervision of William Mulholland, Chief Engineer of the Department of Public Service, E. A. Bayley, Assistant Engineer, and Roderick MacKay, Mechanical Constructor.

Annual Convention of the American Water Works Association

A large attendance of members and guests, an unususually large and well arranged exhibit of water-works appliances, a carefully planned and well executed program, interesting excursions and a good time generally were features of the thirty-fourth annual convention of the American Water Works Association, held at Philadelphia, May 11 to 15.

In his presidential address, Robert J. Thomas, of Lowell, Mass., laid stress on the desirability of the American and New England associations getting together on standard specifications for various water-works supplies. The two specifications for cast-iron pipe, for instance, require extra expense at the foundries and, of course, this falls upon the buyers of pipe.

Business Matters

Recent changes in the constitution of the Association substituted a letter ballot for the election of officers from the floor and provided that the second highest candidate for president should be the choice for vice-president. The ballots showed that Geo. G. Earl, of New Orleans, had been elected president and Nicholas S. Hill, Jr., New York City, vice-president for 1914-15. James M. Caird, Troy, N. Y., was reëlected treasurer and Allen Hazen, of New York City, and A. W. Cuddeback, of Paterson, N. J., were elected as Trustees. We venture to prophesy that the executive committee will reappoint John M. Diven, of Troy, N. Y., as secretary and editor.

Cincinnati was chosen as the next meeting place by a vote of 160 in its favor, against 43 for Columbus, 21 for San Francisco, 19 for Salt Lake City and 8 votes scattered among four cities. Of ten cities desiring the convention, only Columbus and Salt Lake City had members present to urge their claims.

Steps taken a year ago to organize a chemical and bacteriological section were continued this year, but with only a half-dozen present for the purpose. A committee of five, with W. F. Montfort, of St. Louis, Mo., as Chairman, will frame bylaws for the section and submit them to the Executive Committee of the Association for approval.

Committee reports were mostly of the "progress" type. The Committee on Permanent Headquarters submitted a divided report. The majority favored quarters in the Engineering Societies Building, New York City; the minority did not believe the finances of the Association warrant such a move at present. The minority report was adopted and the committee was discharged. The Committee on Water Consumption reported that it had collected and tabulated consumption figures for 150 cities, and that the table would be sent out to the several cities for revision and to fill in missing information before it is published. Special stress was laid on the importance of keeping separate records of domestic consumption. The Committee on Tabulation of Rates and Other Information promises to publish soon a pamphlet of rates and other figures for 600 cities. Good news was received from the committees on Standard Specifications for Cast-Iron Pipes and for Hydrants and Valves to the effect that there is a prospect of an agreement with the New England Water Works Association on a single specification for each class of material. The Committee on Standard Specifications for Wrought Iron Pipe intimated that some years would be required to formulate a complete report but promised interim reports dealing with portions of its subject. The following committees were discharged: Fire Protection, Uniform Annual Accounts and Reports, National Bureau or Department of Health. The Committee on Electrolysis asked to be discharged, but was continued in order that it might keep an eye out for important new happenings.

Papers and Discussions

Nearly all the papers had been printed in advance—nine in the March *Journal* of the Association and nearly as many in separate pamphlets for distribution at the convention.

About ten of the papers dealt with some phase of water purification or with laboratory work. The paper which produced the most discussion was "Present Day Filtration Practice."* by George A. Johnson, of New York City. A number of speakers were of the opinion that Mr. Johnson had allowed himself to become a special pleader for mechanical as against slow sand filtration, and these and others urged that in any case Mr. Johnson's figures of the relative cost of the two methods were unduly high

*A lengthy paper, presented in abstract at the March meeting of the New York Section and printed in full in the March "Journal" of the Association, but thrown open to discussion at the annual convention.

for slow sand and unduly low for mechanical filters. This line of discussion was led by John H. Gregory, of New York, and concurred in more or less fully by J. N. Chester, Theo. Liesen and R. S. Weston. Unfortunately, Mr. Johnson was unable to be present to defend his paper, owing to death in his family, but presumably he will answer his critics in a future number of the *Journal* of the Association.

A lengthy paper on "The Purification of Water by the Ultra-Violet Rays," was read by Max Von Recklinghausen. The consensus of opinion among those who discussed the paper was that the process described is scarcely on a practicable basis, in view of the expense for capital charges, electric current, repairs and maintenance, which come on top of the necessary preliminary treatment to effect a high degree of both clarification and color reduction before the ultra-violet rays are applied to the water.

Three papers which had some elements in common and which were discussed together were: "The Individuality of Public Utilities, and Particularly Water-Works," by W. E. Miller, of the engineering staff of the Wisconsin Railroad Commission; "Pipe Distribution Systems," by Nicholas S. Hill, Jr., New York City; and "Equitable Hydrant Rentals and Better Methods for Proportioning Fire Protection Costs," by John W. Alvord, of Chicago. Mr. Miller showed the fallacy of the popular notion of comparing the water rates of one city with those of another, in view of the great differences in such cost factors as average diameters, sizes and trench depths of water mains, pumping conditions, percentage of population served and rate of population growth. Mr. Hill called attention to the fact that although the cost of distribution systems may run to 60% of the total cost of a water-works plant, experts are seldom called in to advise on distribution systems. The steps in the design of a distribution system will be set forth in detail in the printed paper. Mr. Alvord's paper outlined and gave reasons for a system of fire-protection charges which comprises a hydrant rental "to cover interest, maintenance and depreciation" and a further charge based on a unit price per "inch-foot of diameter," or "the number of inches of diameter 1 ft. long in a given system of distribution pipe"—a 6-in. pipe being "rated at 6 in.-ft. to every foot," etc. This plan encourages the free use of hydrants and the provision of ample main capacity where both are needed and does not require heavy payments for fire hydrants in outlying districts. J. N. Chester, in discussing Mr. Alvord's paper, said he preferred the plan submitted in Mr. Earl's paper before the Association a few years ago; that is a frontage charge for fire-protection. One speaker thought that the square of the diameter rather than the diameter of the pipe should be used in Mr. Alvord's plan, but to this Mr. Alvord replied that simplicity rather than mathematical exactness is the desirable thing in this case.

At the only evening session during the convention, L. L. Tribus of New York City, and W. P. Mason, of Troy, N. Y., showed some interesting lantern slides; the first illustrating primitive water-supplies in various parts of the world and the latter dealing chiefly with microörganisms found in water. Prof. Edward Bartow, of Urbana, Ill., showed a number of water examination laboratories, some quite small, and some operated by the water-works superintendent or pumping engineer. Paul Hansen, associated with Prof. Bartow in the Illinois Water Survey, talked on the need for better management and records of hundreds of small water-works. He said that if consulting engineers were more commonly employed on water-works operation they would have much more opportunity than they now do to see how the plants they design work when put in use.

"Superintendents Day" was a feature of the convention. A considerable portion of the time at two of the three sessions held on this day was given over to a well filled Question Box. Most of the discussion brought out was on water meters. The consensus of opinion was that meters generally save money for the majority of the consumers who take water through them and that any loss of revenue to the water department on this account is more than made up by saving in operating expenses and by postponement of enlargements of mains, pumping plant and water-supply. There was a division of opinion as to the relative advantages of straight-reading and clock-dial meter registers. Several members confessed a change of heart as to the over-registration of water meters, but generally speaking, such over-registration as was mentioned was due to the accumulation of deposits on plungers or disks. The average life of water meters was put by several speakers at from 20 to 25 years. As to home and factory repairs of meters, the majority of those who spoke on the subject seemed to think that minor repairs should be made at home and major ones at the factory, but this would depend somewhat upon the number of meters to be repaired and the nearness or remoteness of the factory.

A question as to the protection of boilers against bursting when water is shut off street mains for repairs showed an apparent majority of opinion in favor of requiring check valves. Some urged that these are of no use without relief valves. Others maintained that relief valves would very likely become stuck through non use, and still others had but little confidence in the reliability of check valves—either on boiler connections or in water mains. One or two speakers said that with proper piping connections there was but slight danger of boilers bursting when street mains are shut off.

Finally, it may be noted that such papers as were not printed in the March *Journal* will appear, as will the discussions on all the papers, in subsequent issues of the Association's new quarterly.

High-Head Single-Stage Centrifugal Pump Driven by Steam Turbine; Youngstown, Ohio

A unique pump installation has been made in the turbine-driven centrifugal unit recently put into service by the city of Youngstown, Ohio. The results of the acceptance trials are also worthy of notice.

In 1912, the city water-supply proved somewhat inadequate and it was expected that for 1913 the existing pumping equipment would not satisfy all the demands upon it. It was deemed necessary to install immediately a unit having a capacity of 5000 gal. per min. (7,200,000 gal. per 24 hr.) and later on to add a second unit of equal capacity. For the first unit, a centrifugal pump driven by a steam turbine was selected for several reasons.

First, such equipment could be built and installed

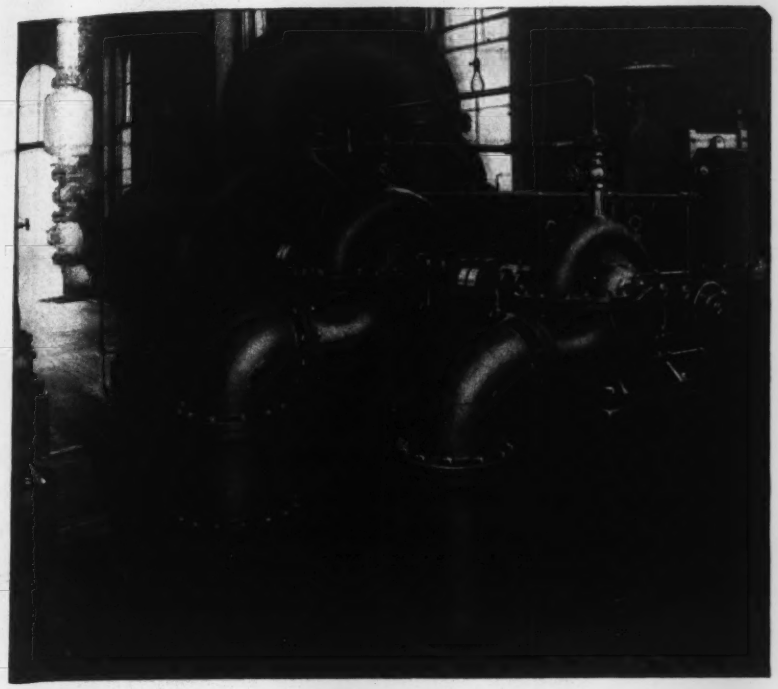


FIG. 1. HIGH-HEAD SINGLE-STAGE TURBINE-DRIVEN CENTRIFUGAL-PUMP UNIT AT YOUNGSTOWN, OHIO

quicker than a triple-expansion reciprocating pumping engine. About nine months was found to be required for the latter, compared with three for the former. Secondly, for the installation of the reciprocating unit, an extension of the station building would be required, while a centrifugal machine could be designed for space available in the existing structure. In the third place, the claimed total cost of pumping, including fixed charges and operating expenses, was expected to be as low or lower than with the reciprocating apparatus, due to decreased fixed charges on investment and in spite of possible higher steam consumption.

Lack of room affected the design of the first unit to a marked extent, as shown by Fig. 1. The space was very limited even for a turbine-driven pump and it was advisable to use a direct-connected rather than a geared type. A speed of 1600 to 1700 r.p.m. was necessary for reasonable turbine economy. With such a speed, only a single-stage pump was considered feasible.

A question arose in regard to the combination of a centrifugal pump working with plunger pumps, there being only a single suction line from the filter plant to the main pumping station—a 48-in. pipe 300 ft. long. The reciprocating units cause surges in the suction line which some claimed would render the centrifugal unit inoperative. It was necessary to run some risk of operating difficulties, but none developed.

TURBINE—The turbine is a multistage impulse type, with ten wheels in as many pressure-stage chambers. This design gave low steam velocity, large clearances about the bucket, and minimum leakage from stage to stage. Carbon packing rings, floating radially, were used on the shaft. The turbine has two governors—one a direct-connected type intended to keep the speed within 1700 and 1800 r.p.m. and serving more as an emergency stop. There is a throttling type also, actuated by the pressure on the pumps to maintain fixed pressure regardless of the quantity demanded.

There was no room for a waterworks type surface condenser and a jet type was necessary. The chief objection to this form for this work was the additional power for driving the auxiliary pumps. A multijet type was selected which ejected air and condensed the steam simultaneously by means of water jets and required a single pump. This used from 30 to 50% more water than the ordinary jet condenser, but that was compensated by driving the circulating pump from an extension of

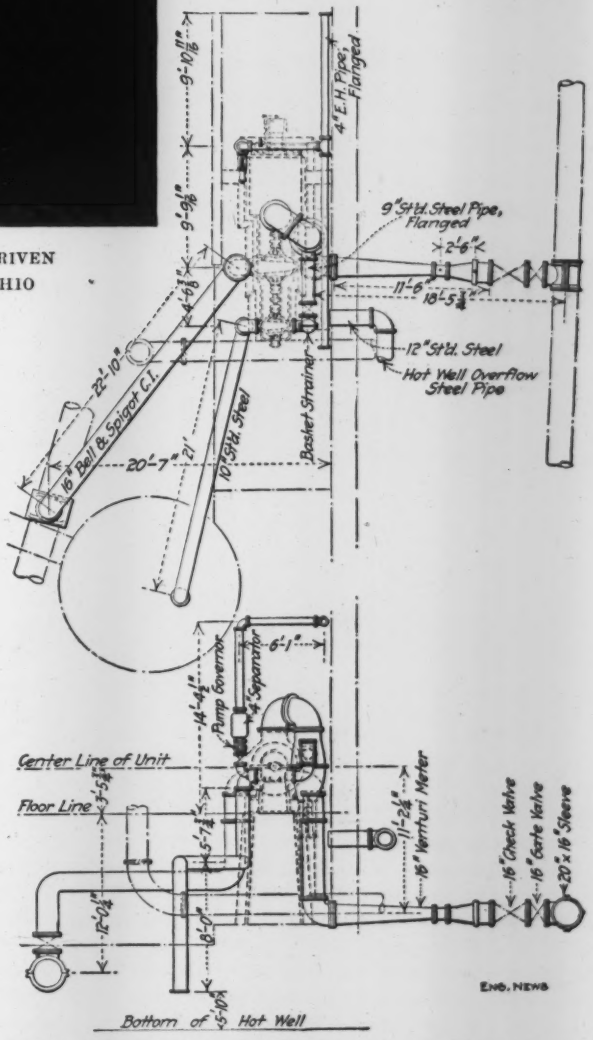


FIG. 2. PIPE LAYOUT FOR NEW UNIT; YOUNGSTOWN PUMPING STATION

the main-pump shaft (directly connected to the steam turbine) to give the benefit of lower steam consumption of the main turbine over an independent auxiliary.

Space limitations made it necessary to take the turbine

exhaust out at the top of the machine and around through two elbows into the top of the condenser. This allowed the condenser to go between the turbine and station wall where it occupied minimum space. This disposition of the exhaust was a departure from ordinary turbine practice, the objection to which was the possibility of water accumulating in the bottom of the casing. To overcome this, a ¾-in. drain pipe was run to the condenser throat. To prevent water backing up through the exhaust pipe into the turbine casing, the condenser was given a vacuum breaker. Should the water back up into the condenser shell, through insufficient pressure of ejecting water, a float-operated valve would open to break the vacuum. A minimum pressure of 9 lb. per square inch at the condenser nozzles is necessary for proper operation. The condenser discharge overflows into a hot well and from there goes to the river through a 12-in. pipe. This arrangement gives an average condenser pressure of 2 in. absolute.

PUMP—The working head ranged from 90 to 110 lb. per sq.in., which is some three times higher than ordinarily used for single-stage units. No data were available for American practice with high-head single-stage pumps of such large capacity. However, from previous experience the designers believed they could obtain a good efficiency with a single-stage unit if proper provisions were made for sealing the impeller against leakage from discharge back to suction. Therefore, the impeller was run close to the casing walls to give an ejector effect which would reduce the tendency of back leakage. Labyrinth packings were also utilized and a marine-type thrust bearing to hold the rotor in the rigid position necessary with small clearances. The suction and discharge openings are 14 in. in diameter.

The condenser pump is of the same type (8 in. size designed for 1350 gal. per min. against 44 ft.). The Venturi meter shown in Fig. 2 is connected to an indicator and recorder. A gage board shows suction, discharge, steam and exhaust pressures.

TESTS—In the acceptance test it was impossible accurately to measure the steam used as delivered from the condenser, nor could the boilers be isolated for measuring steam generated. It was necessary, therefore, to use a flow meter in the turbine inlet. The results check closely with flow readings made at the turbine factory with a surface condenser and brake load. Water and suction pressures were taken with a gage which was calibrated immediately after the trials. Readings of quantity delivered by the pumps were taken with Venturi meters which were guaranteed to be accurate within 2%; no better means was at hand for measuring the delivery and the Venturi readings were taken as correct. Results of the test through the working range of the pump are given in the accompanying table.

Maximum pump capacity was found to be 5840 gal. per min. against a total head of 256 ft., which is believed by the makers to be the best recorded performance for a single-stage high-head direct-connected pump. The maximum duty obtained was 89,000,000 ft.-lb. per 1000 lb. of dry steam, some 11.2% better than the guarantee (80,000,000 ft.-lb.).

The table of test results shows from 80,000,000 to 89,000,000 over the working range, and allowing for possible inaccuracies of the Venturi meter it is probable

TEST RESULTS FOR SINGLE-STAGE TURBINE-DRIVEN PUMP; YOUNGSTOWN, OHIO, APR. 13, 19[illegible]

Discharge head, ft.	Lift, ft.	Total head, ft.	Gal. per min.	Lb. dry steam	Water hp. developed	Duty (Million ft.-lb.
187	15.01	202.01	6100	7940	313	[illegible]
189.5	15.01	204.51	6100	7630	319	[illegible]
210.1	13.58	223.68	5700	7280	325.5	[illegible]
212.7	13.58	226.28	5690	7340	330	[illegible]
212.7	12.8	225.5	5530	7110	319.5	[illegible]
217.1	12.22	229.32	5400	6960	313	[illegible]
219.6	12.8	232.4	5400	7170	318	[illegible]
222	12.8	234.8	5350	7380	317.5	[illegible]
223	12.22	235.22	5020	7050	301	[illegible]
224	12.22	236.22	5020	7270	300	[illegible]
226.8	11.68	238.48	4500	7036	268.6	[illegible]
228.6	12.8	241.4	5425	7600	327.2	[illegible]
228.8	12.22	241.02	4770	7220	290.8	[illegible]
228.8	12.22	241.02	4550	7000	279	[illegible]
228.8	11.10	239.9	4400	6815	266	[illegible]
231	12.22	243.22	4725	7130	291.8	[illegible]
240.2	12.79	253	5340	8600	352	[illegible]
261	12.79	273.77	5800	9550	397	[illegible]
263.2	12.79	276	5840	9550	402	[illegible]

that somewhat more than 80,000,000 is obtained on normal operation. With a duty of 80,000,000 (equivalent to a steam consumption of 24.9 lb. per water horsepower) and with 5000 gal. per min. against 110 lb. pressure, there results a total steam consumption of 7980 lb. per hr., which means 938 lb. of coal for an evaporation of 8½ lb. of steam per pound of coal. This gives 11.25 tons per day for which the local cost is $1.95 per ton. The fuel cost per day then is $22.50, or about $8000 per year. Taking interest and depreciation as 14% of the total cost of the installation (about $10,000), the total cost for operation (exclusive of labor and repairs) runs up to $9400 per year.

It is reported that the reciprocating pump purchased for future installation has a duty guarantee of 167,000,000 ft.-lb. per 1000 lb. of dry steam, which is about half that of the turbine. The coal bill with the reciprocating unit would drop to $4000, but the interest and depreciation charges if taken at 14% (on $72,000), would rise to $10,000. With an allowance of $400 for cylinder oil and valve parts, the total cost of operating the unit under same conditions as the centrifugal pump would be $14,400, or $5000 per year more (according to turbine builders' estimates).

The turbine for this unit was built by the Kerr Turbine Co., of Wellsville, N. Y. The pumps were built by the Wilson-Snyder Centrifugal Pump Co., of Pittsburgh. The multijet condenser was made by Schütte & Koerting of Philadelphia.

Some Tests of Steel Pipe

A series of tests of steel pipe, Van Stone joints and acetylene welds was made at the Simmons Pipe Bending Works, Newark, N. J., on May 12, in the presence of a number of visiting engineers. The test pieces were laid horizontally against two stops placed about 4 ft. 6½ in. on centers and the load applied horizontally midway in the length of the pipe. The rupturing load and the corresponding deflections of the pipe were observed.

The first piece tested was a 6-in. standard-weight steel pipe. The pipe failed under a load of 16 tons. The deflection was 2 in.

Two pieces of 6-in. pipe lapped and welded together by the oxyacetylene process were subjected to a central load applied on the weld. The weld failed by tension under a load of 18 tons. The total deflection was 2½ in. At 16 tons the deflection was 2 in. The type of weld is shown in Fig. 1, detail *A*.

Two pieces of 6-in. pipe, one fitted with a rolled-steel screwed flange, the other with an ordinary Van Stone joint (see Fig. 1, detail B), with a rolled-steel flange, were bolted together. The thread of the standard-flanged pipe failed at 12 tons. The total deflection before the break was 1 in.

It was then attempted to straighten or rupture the lap of a 6-in. pipe. The pipe was held firmly just back

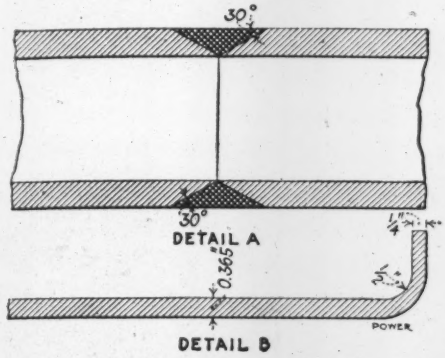


FIG. 1. DETAIL A—METHOD OF WELDING TWO PIPES DETAIL B—ORDINARY VAN STONE LAP

of the flange and a plunger introduced until it pressed against the inner face of a steel dished head welded to the other end of the pipe. The flange started to straighten at 18 tons, but was still holding fairly well (having deflected not more than ⅛ to ¼ in.) at 60 tons. The same sort of test was made on a pipe equipped with a reinforced lap (a lap turned back upon itself) with about the same results except that at 60 tons the welded head in the opposite end of the piece failed.

Another interesting test to prove that the Van Stone joint is strong enough for any normal service, was run in March. The Van Stone flange on a 10-in. pipe was hammered flat, cold; the outside diameter of pipe and lap was 14½ in. The pipe was placed against a 14-in.

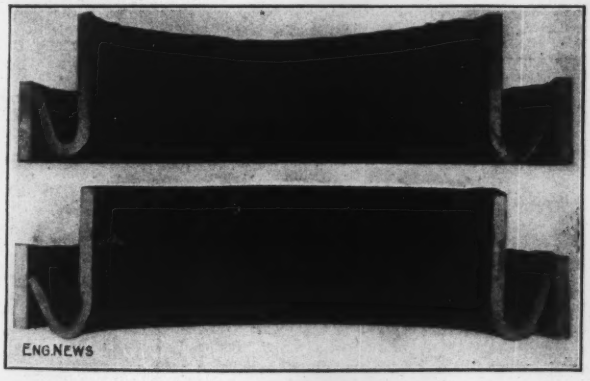


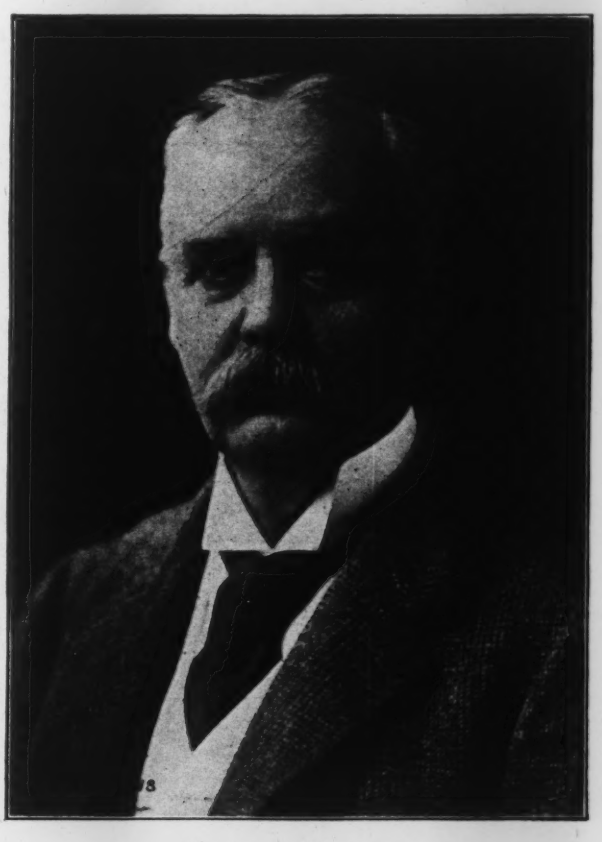
FIG. 2. A COLUMN TEST OF 10-IN. ORDINARY VAN STONE JOINT

pipe and pressure applied. The Van Stone lap on the 10-in. pipe was bent back and the pipe pushed cold through the 14-in. piece under 53 tons pressure. The lap was not fractured, (Fig. 2).

The data of these tests were supplied us by M. Wesney Ward, New York representative of the Simmons Pipe Bending Co., 30 Church St., New York City.

A Civil Engineer President of the Philadelphia & Reading Ry.

As noted in our issue of last week, Theodore Voorhees, M. Am. Soc. C. E., has been elected President of the Philadelphia & Reading Ry. to succeed the late George F. Baer. Mr. Voorhees was born in New York City in 1847 and graduated from the Rensselaer Polytechnic In-



THEODORE VOORHEES

stitute in 1869. He was elected a member of the American Society of Civil Engineers in 1885.

Mr. Voorhees is chiefly distinguished for his record as an operating officer; but his first four years of railway training were in the engineering department of the Delaware, Lackawanna & Western R.R., and much of his subsequent work in the operating departments of this railway, the Delaware & Hudson R.R., the New York Central and Hudson River R.R. and the Philadelphia & Reading Ry. had to do with improvements in operating conditions, which called for engineering knowledge, experience and foresight as well as for executive ability.

When Mr. Voorhees was General Superintendent of the New York Central & Hudson River R.R. (1891-93), that railway first installed the controlled manual block-signal system on its main line from New York City to Buffalo, one of the most radical steps in railway-signal practice which had been made up to that time. He is noted among signal engineers also for the introduction of the first "normal-danger" automatic block signals.

Explosion in a Steel-Frame Factory Building, Detroit, Mich.

On Friday morning, May 15, shortly before 10 o'clock, the plant of the Mexican Crude Rubber Co., located at Solvay and Mackie Sts., Detroit, Mich., was almost totally destroyed by a series of explosions, accompanied by a swift fire. In the plant at the time were chemists and operators, 27 in number. Of these, 9 were killed outright, one died later and 6 were injured more or less seriously.

The factory building in which the explosion took place, fairly isolated from adjacent buildings, was 50x200 ft. in plan, one story high and no basement. At the side, the building was 16 ft. high, at the eaves 13 ft. Structurally, the building was a steel frame with curtain walls and roof of cement mortar on ribbed metal lath. Heavy 8-in. H-sections formed the wall columns, 16 ft. c. to c., with the exception of the two end bays which were only 12 ft. wide. Intermediate vertical studs of lighter steel section were used. The ribbed metal lath was fastened to the steel sections by a special clip arrangement. The curtain walls 3 in. thick, were carried to a height of 5 ft. above the floor level, above this, glazed metal window sash were used to within about 2 ft. of the eave line.

The general arrangement of the interior is shown in the accompanying sketched plan (Fig. 1). The only copy

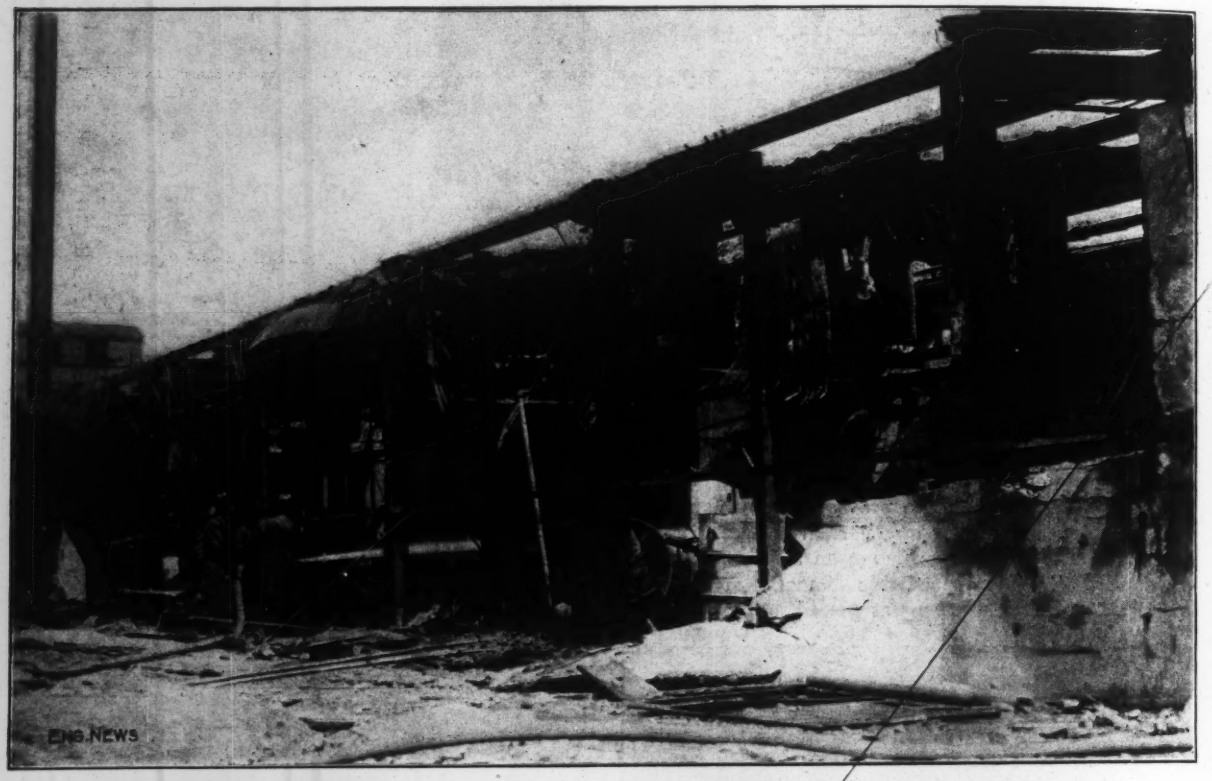


FIG. 1. EXTERIOR VIEW OF THE REAR OF THE FACTORY AFTER EXPLOSION AND FIRE

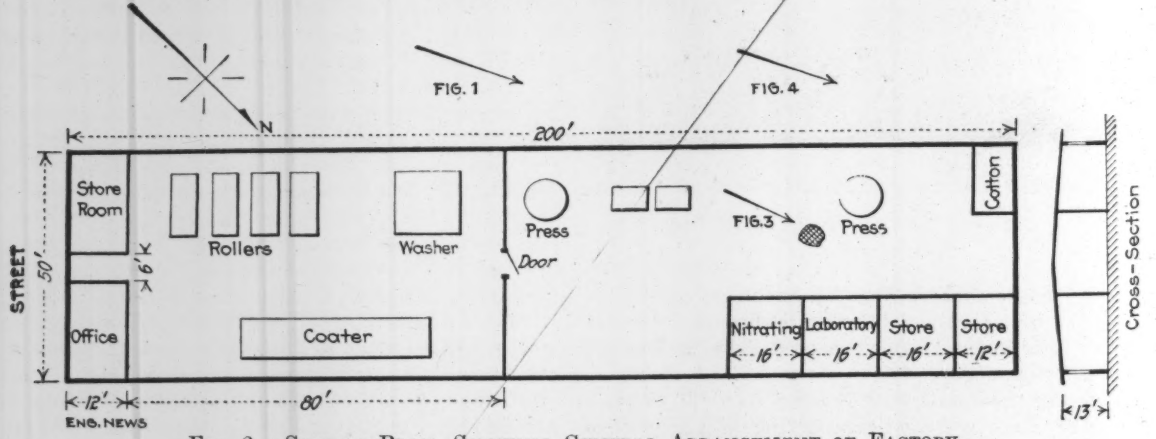


FIG. 2. SKETCH PLAN, SHOWING GENERAL ARRANGEMENT OF FACTORY
(Location of views in Figs. 1, 3 and 4 indicated on sketch.)

of the blueprints of the building was destroyed in the fire. The interior arrangements shown are as indicated in an interview with the factory superintendent. The supply stores of explosive chemicals and raw cotton were kept in a small separate brick building about 30 ft. to the rear of the main buildings, and were brought in as required.

The manufacture of artificial leather, usually conducted in connection with the manufacture of explosives, involves the use of raw materials such as collodium cotton, cellulose, ether, coal-tar benzol, amyl alcohol, camphor oil and castor oil. These materials are all more or less explosive and inflammatory and require care and intelligence in storage and handling. As the explosion

FIG. 3. INTERIOR VIEW OF A FACTORY RECENTLY DESTROYED

(Shows in detail how the roof slab down the central section was blown completely away.)

killed outright everyone in the immediate vicinity, it will probably never be known definitely what its cause was.

In the rear of the building were storage rooms, a laboratory, cotton picker, presses, etc. A transverse partition wall separated this room from the central section of the factory in which the finished material was produced. In this finishing room were coaters, rollers, etc. The front part of the building was partitioned off to make a central passageway, an office and a storeroom as indicated. All the interior partitions were cement-mortar plaster on ribbed metal lath.

The accompanying views show what the explosion did to the building. The framework of the rear section of the building, which caught the main force of the explosion, was almost stripped of its metal lath and cement-mortar wall and roof sheathing. The force of the explosion cleaned out practically every wall panel in the rear 125 ft. and the entire middle section of the roof down to the transverse partition. In some places curtain walls were simply laid right over onto the ground. In other places, the curtain-wall sections were hurled 30 ft. away from the building. All sash in this rear section were thrown clear away from the wall. In many places a sash, approximately 4x6 ft. stripped absolutely clean of its glass, could be seen lying 20 ft. or so away from the building.

Down the center of the rear section up to the transverse wall, the roof slab was blown entirely away. At the sides, over the sections from the purlins to the eaves, practically all sections of the roof slab had been torn loose and lifted

FIG. 4. A DETAIL OF DESTRUCTION IN THE FACTORY EXPLOSION

(Piled together at the left and in the immediate foreground are the deglazed metal sash. A panel of the curtain wall is also piled up with the sash.)

up, some sections to hang down over the eaves on the outside, others to fall back and hang suspended into the building.

The steel frame seems to have suffered little damage. Some of the exterior H-columns are buckled a little; the heat from the fire in the forward section of the building was probably intense. Horizontal angles in the rear partition of what was the office were bent and twisted with the heat.

The location of the explosion is indicated to some extent by the directions in which the interior partitions were thrown. The central transverse partition was thrown forward, and the partition in front of the Nitrating Room (Fig. 1) caved toward the outside wall. The position of these partitions and the presence of a hole about 3 ft. in diameter and 6 in. deep, ground into the concrete floor (hatched the sketch) indicate that one of the principal explosions occurred at this point. A large heavy milk can full of collodium cotton was known to be here and pieces of sheet metal were driven into adjacent timbers. The partitions between the storerooms in the northeast corner of the building are almost intact.

Rapid Erection of a Large Reinforced-Concrete Stadium

The construction of a large reinforced-concrete baseball stadium at the Federal League Grounds, Fourth Ave. and 3rd St., Brooklyn, N. Y., was commenced Mar. 9, 1914. On Apr. 20, the last concrete was placed for the structure. On May 5, all forms were stripped and on May 11 the completed stand was turned over to an audience of 15,000 people viewing the first game of the season. The work cost about $275,000. The rate of erection is shown in the accompanying tabulation.

PROGRESS SCHEDULE

Grandstand and Pavilion	Progress schedule proposed Start	Finish	Actual finish date	Average number of men Laborers	Mechanics
Excavation, 4000 cu.yd.	Mar. 9	Mar. 21	Mar. 27	80	5
Concrete footings, 1500 cu.yd.	Mar. 12	Mar. 24	Mar. 29	70	5
Backfilling, 2500 cu.yd.	Mar. 18	Mar. 26	Mar. 30	25	1
Grading and removing 1500 cu.yd. earth with 5 teams	Mar. 18	Mar. 28	May 1	20	1
Three concreting towers completely equipped	Mar. 11	Mar. 19	Mar. 19	10	12
All forms set	Mar. 13	Apr. 27	Apr. 6	4	25
Pouring 5000 cu.yd. concrete	Mar. 25	Apr. 25	Apr. 20	72	6
All forms removed			May 5		

The plans and specifications for the stadium are the same as those prepared for the Federal League Baseball Grounds in Chicago. The principal modifications were as to grades and code regulations. The Chicago contract was signed on Feb. 27 and completed on A[illegible]23; the time elapsed being the same as on the Brook[illegible] stands. The work was carried out in Brooklyn in acco[illegible]ce with specifications, but in Chicago the contractors w[illegible] obliged to substitute steelwork for the reinforced-co[illegible]te work specified, because the Chicago Building D[illegible]rtment would not permit such a concrete structure t[illegible]e used until the concrete had set 40 days. It will be n[illegible]d that at Brooklyn only 23 days elapsed from the last pouring of concrete to the loading of the stands.

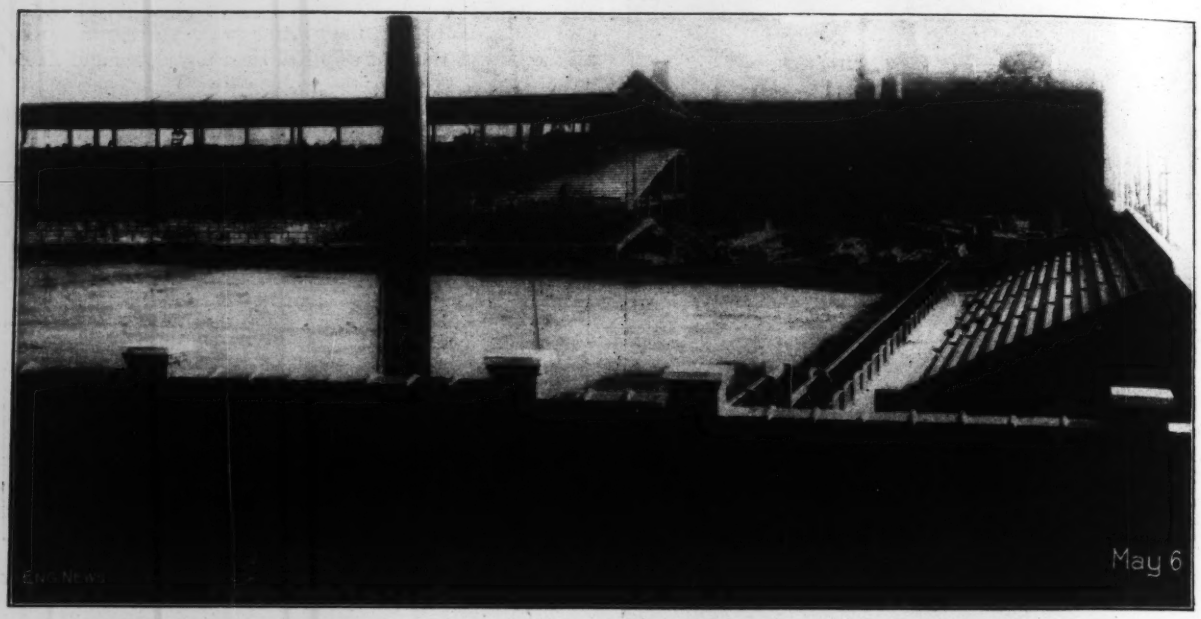


Fig. 1. The flagpole in the foreground is 200 ft. high and weighs 10 tons. It was the nickel-steel mast of the American cup-defender "Reliance." Its foundation consists of a reinforced-concrete footing, 18x18 ft., by 4 ft. thick. The mast is not guyed.

Fig. 2. Concreting under Way

Fig. 3. The Steel Roof

FIGS. 1-3. PROGRESS VIEWS OF STADIUM, BLEACHER, AND 20-FT. BRICK WALL
(Dates shown on each view.)

THE CONTRACT—The contract comprised all work necessary for the erection of a curved-plan grandstand 865x119 ft. in area and about 55 ft. high; a bleacher, and a 20-ft. brick wall 1100 ft. long, 12 in. thick, with 20-in. brick piers spaced on 20-ft. centers. Each pier of the brick wall was reinforced against wind pressure by two 8-in. channel uprights, 14 ft. high and kneebraced

at the bottom. The channels were fastened to the wall by connecting rods embedded in the brickwork. The grandstand is of reinforced concrete from the ground to the top seat-steps. It is supported on eight reinforced-concrete columns of length decreasing from 29 ft. at the rear or outer chord to 3 ft. at the front or inner. The seat-steps rest on concrete girders 12 in. wide spanning these columns.

The steel roof of the grandstand is carried on two lines of steel columns—numbers 1 and 5, counting the outer chord as number 1. The roof slopes upward from the outer chord to the other support, a distance of about 66 ft. and a slope of about 1:5. From the second point of support, it cantilevers out 24 ft. 9⅛ in., the upper chords of the trusses declining toward the lower throughout this distance and joining at the end. This whole grandstand structure is designed with the idea of eventually adding another tier (steel) of seats. When this is done, the roof, with the exception of the cantilevered portion, will be raised. The cantilevered section will form the inside of the new tier which will continue rising to the outer chord.

The runways for entrance and rapid exit are symmetrical about a central axis; starting from ground elevation at the center and inclined at about 1:5 to three successive landings. The final landing is a platform at the top of the outer two rows of columns, and surrounds the whole structure. Adjacent to landings are mezzanine floors for the support of offices and clubrooms. These runways, ramps and mezzanines are an integral part of the construction.

Expansion joints were placed about every 55 ft., at which points the columns and girders were doubled and the floor reinforcement divided on the line between the girders. The joint was filled with asphalt.

FIG. 4. VIEW SHOWING LOCATIONS OF TWO OF THE THREE CONCRETE TOWERS

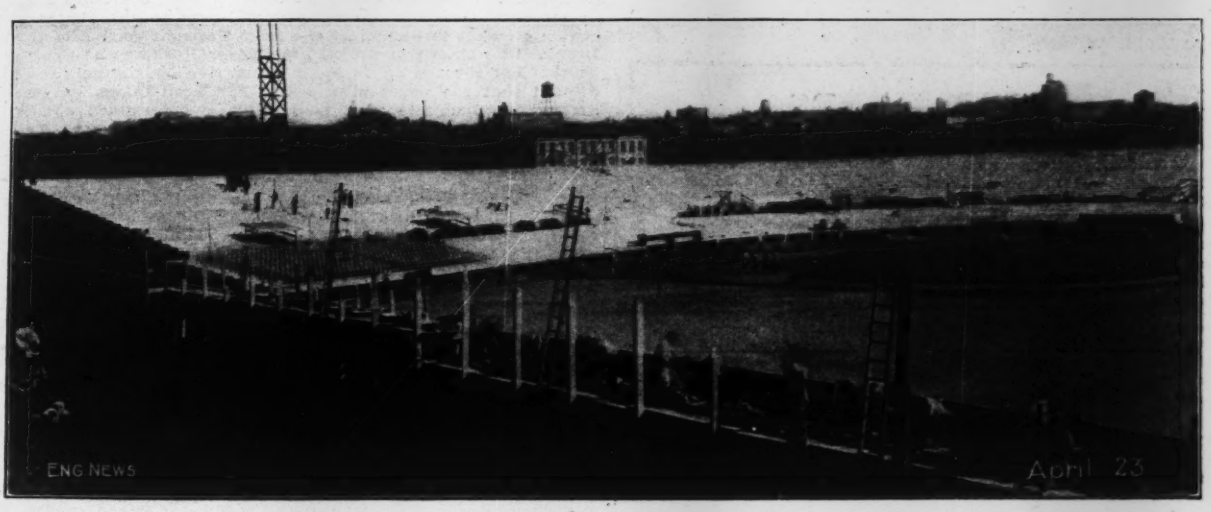


FIG. 5. CONCRETE WORK COMPLETED

The Chicago footings were designed to carry 5000 lb. per sq.ft.; but borings in Brooklyn showed that the soil was only good for 2000 lb. per sq.ft. This necessitated the enlarging in plan of 380 footings in order to obtain sufficient carrying capacity. All footings over 8x8 ft. in plan were made reinforced-concrete footings; those larger were made of plain concrete stepped up from the base to the column.

CONSTRUCTION—In addition to the feature of speed, that of efficient organization should be noted. The timber was cut to size by two electric saws. The lumber and reinforcing rods were trucked to the field and dis-

tributed where needed. The plant comprised three 90-ft. towers, equipped with concrete chutes, 96 ft. long; ¾-cu.yd. electric-driven mixers, and electric hoists. The plant was erected at the exterior chord of the work and all concreting materials were delivered at the plant.

The concrete was mixed steadily and from the tower was conveyed by chute to a central wood distributing-hopper of about 5-tons capacity. From this hopper, smaller chutes radiated. The hopper acted as a reducing valve.

The main chutes were set at an inclination of 1:4 and worked satisfactorily at this angle. The wetness of the mix was varied with temperature in order to secure uniform flow. The slope of the stand was also about 1:4 and it was feared that the wet concrete would bulge up the lower steps from the upper; but by pouring the concrete in the upper-step forms, it had set sufficiently when it reached the lower step to prevent the expected bulging.

The average total number of men engaged in the work was about 875, divided as follows: carpenters, 250; carpenter's helpers, 60; metal lathers, 75; concrete laborers, 150. In addition to these, there were about 15 timekeepers, foremen and draftsmen. The men engaged in concrete work numbered 550. The balance, about 325, were bricklayers, structural-steel men, painters, plumbers, sheet-metal men, plasterers and laborers.

PERSONNEL

The P. J. Carlin Construction Co., of New York City, was general contractor (J. P. Carlin, President). The architect was C. B. Comstock. James Stephenson was superintendent at the site for the reinforced-concrete construction.

NEWS NOTES

A Pittsburgh Tenement Collapsed During a Storm on the night of May 12. In the house at the time were 50 persons, of whom one was killed and a number injured.

A Magazine Explosion on the Canal Zone, caused by a brush fire, which made its way too near the dynamite shanty, resulted in the killing of eight persons and the injury of about 19 others, on May 5. Six of the dead and most of the wounded were firemen summoned to combat the flames.

Argument on the Injunction Suit brought by the Federal Government to prevent the Chicago Sanitary District from diverting more than 4127 cu.ft. per sec. from Lake Michigan was begun on May 7. The injunction was applied for several years ago.

A Heavy Rainfall in Southern Michigan occurred May 11-12. Many cellars were flooded in Detroit. The most serious damage appears to have occurred in the vicinity of Kalamazoo and Adrian. Crops were wiped out in many places and one man was drowned.

Paving by Municipal Day Labor, Duluth, Minn.—The city of Duluth, Minn., is experimenting with pavement work by city labor. The paving of West Superior St. from 15th to 13th Aves., with vitrified brick on a concrete base, at an estimated cost of $65,000, has been begun.

A Minor City Planning Competition, having as its subject the treatment of the "four corners" at two street intersections, is announced by Prof. George A. Damon, Dean of Engineering, Throop College of Technology, Pasadena, Calif. Prizes of $200, $100 and $50 are offered. All drawings must be in the hands of Dean Damon by Sept. 1, 1914, and awards must be made by Sept. 10.

Concrete Road Specifications have been incorporated in a booklet published by the Universal Portland Cement Co., Chicago, Ill. This booklet includes the Recommended Practice adopted by the National Conference on Concrete Road Building, held at Chicago, Feb., 1914, and the Proposed Standard Specifications of the American Concrete Institute for the Construction of One-Course Concrete Highway, One-Course Concrete Street Pavement and Two-Course Concrete Street Pavement.

A Temporary Wood Bridge Was Wrecked at Tiffin, O., on May 12, by driftwood. One of the middle bents failed, causing the structure to sag on one side; the driftwood then carried it away. The Monroe St. Bridge was first erected at Washington St. When the new and permanent Washington St. bridge was completed the temporary structure was moved to Monroe St.

The Second 15-Cu.yd. Dipper Dredge for the Panama Canal left New York harbor in tow of a tug on Apr. 9. This is the "Paraiso," a duplicate of the "Gamboa," now at work on the canal, which was 26 days on the voyage from New York to Colon. These dredges were described in "Engineering News," of Mar. 12, and are probably the most powerful dredges of their type afloat. They were built by the Bucyrus Co., South Milwaukee, Wis.

New York State Road Contractors Sued—Proceedings were begun on May 10 to recover thousands of dollars of the money expended by New York State during the last year or two on road work. Nine contractors and their bondsmen are being sued for amounts varying from $6000 to $13,000, for alleged failure to construct the roads according to the provisions of the contracts. Under the state law all contractors are bonded for 50% of the amount of their contracts, and the bond is held until the final acceptance of the road by the State.

Asphalt Pavements in Chicago Cheaper—According to the Chicago "Tribune," the average price per square yard of asphalt pavement at last season's awards of the Board of Local Improvements was $1.84, while in bids opened recently the average price was only $1.69, a decrease of about 9%. If the city lays the usual season's amount of about 1,000,000 sq.yd., this will mean a saving of $150,000. The reason for the sudden drop in price is claimed to be due to a lack of agreement among asphalt-paving contractors, who have hitherto monopolized the field. The chief new competitor is the Barber Asphalt Paving Co., which has already secured a score or more contracts at $1.71 per sq.yd.

A Blast Adjacent to a Shopping District dropped stones into a crowd of shoppers on Tremont Ave., New York City, on May 16. Seven persons were injured. The blast was shot in an excavation for an apartment house in the shopping center of what is known as the East Tremont section of the Bronx. The blast was set off after several others and was to be the last for the day. An investigation by the police indicated that the usual precautions had been taken, but the amount of dynamite used could not be determined as the men had apparently left immediately after the shot. The contractor is Matteo Capobianto, of 3400 Third Ave. The accident is being investigated by the Bureau of Combustibles.

A Severe Marine Boiler Explosion on the Old Dominion steamer "Jefferson" off Cape Henry on the night of May 11 resulted in the death of 10 men. Inspection of the boiler after the accident indicated that low water was the cause. The furnace crown has sagged and the upper right-hand portion of the tube sheet is blown entirely away from 12 tubes. The ends of the stay tubes are in good condition. The one from which the sheet blew entirely away is not distorted and the hole in the sheet is perfect, except that it was enlarged just enough to allow the pressure (190 lb. normally) to force it over the beaded tube ends. The ashes were being removed at the time of the accident and on this ship the pressure usually dropped 30 lb. when this work was being done.

The Recent Oklahoma Flood, noted last week in these columns, washed out the following bridges across the South Canadian River: Santa Fé railroad bridge, at Canadian, Tex.; Wichita Falls Ry. bridge, near Camargo, Okla.; wagon bridge, Taloga; Kansas, Mexico & Orient Ry. bridge, near Oakwood; Frisco railroad bridge, Bridgeport; wagon bridge, Tedda; Rock Island bridge, Union City; Frisco bridge, near Tuttle; Missouri, Kansas & Texas Ry. bridge, Tyrola. The following bridges over the Cimarron River were destroyed; Kansas, Mexico & Orient Ry. bridge, near Cleo; Rock Island railroad bridge, near Cleo; Frisco bridge, near Ames; the old wagon bridge at Guthrie was partially washed out. Across the North Canadian, the Wichita Falls Ry. bridge at Laverne was washed out by a 6-ft. rise.

An Earthquake in Sicily destroyed many villages on the eastern slope of Mt. Etna and killed nearly 200 persons, on May 9. The sole industry of this part of the island is vine growing, and most of the villages have an agricultural population. The buildings are of light construction. Railroads, bridges and tunnels were wrecked.

For several days previous to the heavy earthquake, tremors were felt, accompanied by an eruption of Mt. Etna. The first severe shock was felt at 7 p.m., on May 9, interrupting

railroad and telephonic communication. According to the New York "Herald," Prof. Annibale Ricco, Director of the Etna Observatory, considered the disaster to have been due to a subterranean infiltration of sea water, which on reaching the ignited zone, caused the internal explosion. He says this was proved by the jets of boiling vapor which burst forth at several points, where the earthquake had caused deep crevices.

Engineers of Philadelphia—A joint meeting of engineers representing the membership of all the scientific and engineering societies of Philadelphia was held on the evening of Friday, May 15, at the Continental Hotel Roof Garden and was attended by between four and five hundred engineers of Philadelphia and vicinity. The object of the meeting was to promote general acquaintance and friendship and aid in the formation of some organization which will represent the entire engineering fraternity of Philadelphia. Following a general reception by the committee in charge and the guests of the evening, the meeting was addressed by Hon. Geo. W. Norris, Director of the Department of Wharves, Docks and Ferries of Philadelphia; Dr. W. W. Kean, President of the American Philosophical Society, which is said to be the oldest scientific society in the United States; Dr. Walton Clark, President of the Franklin Institute, and Dr. Alex. C. Humphreys, President of Stevens Institute of Technology.

The Panama Canal has been opened to commercial traffic. The emergency resulting from the stoppage of traffic on the Tehuantepec Ry., by the Mexican authorities has resulted in a diversion of traffic to the Panama route with consequent congestion. While the ships destined for the Tehuantepec route, arriving at the Panama terminals are not prepared to continue their voyage through the canal, it has been arranged to transship freight through the canal on barges. The first of these barges was to pass across the isthmus through the canal on May 15.

The canal is, of course, not entirely completed. A considerable amount of the machinery, such as the towing locomotives, still remains to be delivered. The locks and lock machinery, however, are sufficiently far advanced so that the canal can readily take care of all the traffic that is likely to use it for a long time to come. The only obstruction in the course of the canal is the Cucaracha slide and the dredges are keeping pace with the advance of this so that vessels can pass it without difficulty.

Iowa Law Requiring the Dragging of Earth Roads Enforced—The systematic use of road drags is one of the duties most specifically required by the new law, an abstract of which was given in "Engineering News," of July 17, 1913. There is a special fund which the law requires to be levied for this one specific purpose. This money must be spent for this one purpose and no other. Road officials whose duty it is to see that roads are dragged at the proper time are liable under the law whether the neglect be theirs or of others upon whom the responsibility has been placed. This applies to those in charge of the county road system, the township system and the roads inside the limits of incorporated towns. The law has recently been tested in the case of the town of Clover Hill (near Des Moines) which has only 35 voters. The four councilmen of the town were indicted for neglect of duty in failing to drag the roads, as provided by the law of 1913, and were recently adjudged guilty and fined $5 each. For a second offense they are liable to a $500 fine or a year in the county jail, or both.

A Very Large Stone-Crushing Plant is to be built by the New Haven Trap Rock Co., at North Branford, Conn. The plant will be located at a point about ten miles east of New Haven and five miles back from Long Island Sound. At this point a deposit of trap rock exists, rising about 200 ft. above the valley and extending westward for several miles. The rock blasted down from the quarry face will be excavated by steam shovels and delivered to an initial crusher of the jaw type able to take in very large blocks of stone. The coarse material discharged from the jaw crusher will be broken by rotary crushers. The first plant to be installed is to have a capacity of 3000 tons of crushed stone per day, and is to be so planned that a second plant of similar capacity can be added when the market demand justifies it. A railway line five miles long will extend from the crushing plant to Long Island Sound where the stone will be loaded on barges for delivery at New York and other ports. An electric power plant will be erected near the site of the quarry furnishing power for all operations in connection with it. The work of designing and erecting the plant is in charge of Preston K. Yates, 30 Church St., New York City.

A Coal Hoisting Derrick on the river front at Montreal, Can., overturned on May 5th and toppled two employees who were working upon it into the water. The current was very swift and the men were drowned. Their bodies, apparently, were caught in the framework of the machine, for they had not been recovered at last accounts. The crane was owned by the Ogdensburg Coal & Towing Co., and was a one-ton coal unloader of the McMyler type. About two days previous to the accident, a shunting engine had hauled the derrick from its winter quarters to the location on the wharf from which it toppled into the river, and it was set there on what appeared to be a good level track. In shunting the derrick from the yard to the wharf, it was brought down quite a steep grade from a high-level to a low-level wharf, and no trouble was noted with it. At the time the derrick toppled over, the men working on it were engaged in reeling on a new steel cable, and the boom of the derrick was pointing inshore, and was, of course, not carrying any load. No work had been done with the derrick since it had been placed on the wharf. As far as is known, the track on which it was located was all right, and no one seems to be able to locate the cause for the overturning.

This type of machine is arranged to swing 360° and is counterweighted at the back against the weight of the boom and bucket, and is also clamped down to a small trestle, which trestle, in turn, is on trucks and can be moved parallel with the face of the wharf. It is probable that the machine was not properly counterweighted or clamped, and that it simply fell off of the trestle; but the testimony of the one survivor and of the other men who were connected with its installation, has not as yet given any definite reason for the overturning.

PERSONALS

Mr. William J. Nixon has resigned as Chief of the Bureau of Electricity, San Francisco, Calif.

Mr. C. D. Peacock has been made City Engineer of Brainerd, Minn., at a salary of $2000 per annum.

Mr. S. B. Harding has resigned as Consulting Engineer and Director of the Modern Steel Structural Co., Waukesha, Wis.

Mr. Frederick T. Parsons has resigned as Deputy Commissioner of the Department of Water Supply, Gas and Electricity of the City of New York.

Mr. Adolph J. Egelhof has been elected a Vice-President of the Rome Corporation, Builders, New York City, in charge of the estimating department.

Mr. A. B. Clenny, for the past year Assistant Engineer for the J. C. Field Engineering Co., of Denison, Tex., has been appointed City Engineer of Denison.

Mr. A. J. Wenzell, M. Am. Soc. C. E., has resigned as Chief Engineer of the Michigan Railway Engineering Co., Kalamazoo, Mich., to engage in other work, with headquarters at 1506 Geddes Ave., Ann Arbor, Mich.

Mr. M. C. Cleveland, recently Engineer of Maintenance-of-Way of the Chicago, Indiana & Southern R.R., at Gibson, Ind., has been appointed Valuation Engineer of the Lehigh Valley R.R.

Mr. J. H. Jackson, former Superintendent of the St. Louis & San Francisco R.R., at Birmingham, Ala., and since April of this year with Baltimore & Ohio R.R., at Baltimore, Md., has been appointed Superintendent of the Newark division of the Baltimore & Ohio R.R., with headquarters at Newark, Ohio.

Mr. Charles Mauro, who is reported to have worked and traveled in Europe, Australia, New Zealand and other places as a gold prospector, has been appointed Deputy Street Cleaning Commissioner for the Borough of Brooklyn, New York City, at a salary of $5000 per annum. For the last 10 years Mr. Mauro has been connected with immigrant railroad traffic work.

Mr. H. E. Bilger, M. Am. Soc. C. E., Senior Highway Engineer, United States Office of Public Roads, Washington, D. C., has resigned to become Road Engineer of the Illinois State Highway Department. He was formerly Division Engineer of the Illinois State Highway Commission. Mr. Bilger is a graduate of Bucknell University and a civil engineering graduate of the University of Missouri. For a number of years he was in railway work.

Prof. T. R. Agg, head of the department of highway engineering at the Iowa State College, Ames, Iowa, has been elected President of the Northwestern Road Congress, a new organization composed of highway engineers and others interested in road work in the states of Iowa, Illinois, Wisconsin, Michigan, North and South Dakota. The road problems of these states are similar and will be considered and discussed at a congress to be held in the coming fall.

Mr. Joseph H. Young, former President of the Spokane, Portland & Seattle Ry., the Oregon Trunk Ry., and the other so called Hill lines in Oregon, has been elected President and General Manager of the Norfolk Southern Ry., succeeding Mr. Charles H. Hix, resigned. Mr. Young is a former Division Superintendent of the Union Pacific Ry., and at one time was General Superintendent and later General Manager of the Colorado & Southern Ry. From 1910 to 1912 he was President of the Alaska Steamship Co. and Vice-President of the Copper River & Northwestern Ry. Mr. Young is a native of Salt Lake City, where he was born in 1864.

An unfortunate similarity of names has caused some annoyance to a well known engineer of New York City. We recorded in our issue of Apr. 23, in this place, the conviction of Spencer J. Stewart, former Division Engineer of New York State Highways, for conspiracy to defraud the state in connection with road-improvement work on Long Island. This engineer is no connection whatever of Spencer W. Stewart, of New York City, who is the President of the Stewart Enginering Corporation, and of the Hydraulic Development Corporation, and is also a director in the Interstate Equipment Co. Spencer W. Stewart is not now and never has been connected with any state, county or city work either as an engineer or a contractor. His activity has been principally in railway location and construction, and in the construction of bridges, foundations, and hydroelectric works.

Mr. Newcomb Carlton, a former Mechanical Engineer of Buffalo, N. Y., and a graduate of Stevens Institute of Technology, has been elected President of the Western Union Telegraph Co., succeeding Mr. Theodore N. Vail, resigned. Mr. Carlton has been Vice-President and executive head of the company for several years past. Until 1899 he was a mechanical engineer in Buffalo, N. Y. He was appointed Director of the Pan-American Exposition in that city in 1899. Here he developed so much executive ability that he was offered a position as Vice-President of the Bell Telephone Co., of Buffalo, which he filled for two years. In 1904 he was made Vice-President of the Westinghouse Electric & Manufacturing Co., Pittsburgh, Penn., and in 1906 became Vice-President and Managing Director of the British Westinghouse Electric & Manufacturing Co., of London. Since 1910 he has been with the Western Union Telegraph Co. in New York City.

Mr. William Mulholland, M. Am. Soc. C. E., Chief Engineer, Department of Public Service, Los Angeles, Calif., was granted the honorary degree of Doctor of Laws by the University of California on May 13. The degree was conferred by President Benjamin Ide Wheeler, to whom the candidate was introduced by Prof. Charles Derleth, Jr., Dean of the College of Civil Engineering, who said:

Mr. President: On behalf of the engineering faculties I present to you a man singularly endowed by those qualities which mark the great engineer. A native of Belfast, Ireland, reared in Dublin, he matriculated for life's course by going to sea, a boy of 14. He left the fatherland, crossed our Isthmus; upon a sailing vessel he entered the Golden Gate in 1877. Ever since in this western country he has been a close student of nature, schooled solely in the great university of experience, so that now he stands before us a vigorous personality, strong, fearless, upright, sound in judgment, keen of vision, a master workman and a leader of men; the veritable pride of engineers. I introduce him further because he is an invaluable servant of our state, an acknowledged authority upon the sources, conveyance, distribution, care and use of water. I have the honor to name the Chief Engineer of the Los Angeles Aqueduct, William Mulholland.

OBITUARY

Peter Carling, Superintendent of the Edison Portland Cement Works at New Village, N. J., died May 14, aged 75 years.

George S. Bruce, a civil engineer of Baltimore, Md., died May 13, aged 62 years. He was connected with the construction of the Florida East Coast Ry.

William Wainwright, Vice-President of the Grand Trunk Ry., died May 14, at Atlantic City, N. J. He was born in England in 1840. In 1862 he went to Canada to become senior clerk in the chief accountants' office of the Grand Trunk Ry.

J. B. Smalley, Assistant General Manager of the Second district of the Chicago, Rock Island & Pacific Ry., Topeka, Kan., died May 8 from a stroke of paralysis, due, it is reported, to overwork in connection with the reconstruction of the line in the flooded districts of western Kansas.

Arthur B. Willmot, M. Am. Inst. M. E., a consulting mining engineer of Toronto, Ont., died May 8, aged 48 years. He was a graduate of the University of Toronto and of Harvard University. For a number of years he was Manager of Mines for the Clergue interests, predecessors of the present Lake Superior Corporation.

Paul L. T. Heroult, M. Am. Inst. M. E., famous as the inventor of the process for extracting aluminum, which bears his name, died recently in Paris, France. He was born in France in 1863. He was educated in England and France, and in 1886, at the age of 23 he invented the Heroult aluminum process. Afterward he was connected with the aluminum industry both in France and in this country. He was a member of the Société des Ingenieurs Civils de France and of various chemical and other learned and scientific societies.

ENGINEERING SOCIETIES

COMING MEETINGS

SIXTH NATIONAL CONFERENCE ON CITY PLANNING.
May 25-27. Toronto, Ont. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

MASTER BOILER MAKERS' ASSOCIATION.
May 25-28. Convention at Philadelphia, Penn. Secy., H. D Vought, 95 Liberty St., New York City.

NATIONAL DISTRICT HEATING ASSOCIATION.
May 26-29. Sixth convention at Rochester, N. Y. Secy., D. L. Gaskill, Greenville, Ohio.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 2-5. Annual convention at Baltimore, Md. Secy., Chas. W. Hunt, 220 W. 57th St., New York City.

MASTER CAR BUILDERS' ASSOCIATION.
June 10-12. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 1112 Karpen Building, Chicago, Ill.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
June 11-13. Annual meeting at Toledo, Ohio. Secy., Frank E. Sanborn, Columbus, Ohio.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 15-17. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 1112 Karpen Building, Chicago, Ill.

Engineers' and Architects' Club of Louisville—On Saturday, May 16, at 6:30 p.m., at the Pendennis Club in Louisville, Ky., the Engineers' and Architects' Club of Louisville tendered Theodore A. Leisen a farewell dinner, in recognition of his services to the Club. The Committee of Arrangements appointed by President Elliott consisted of F. H. Miller, J. M. Johnson and G. W. Hubley. Mr. Leisen is leaving for Detroit to accept a position as Chief Engineer and General Superintendent for the Detroit Water Commission. At the regular meeting of the Club, on May 19, F. S. Schaefer presented a paper on "Farm Draining." The Secretary of the Club is Pierce Butler, 1412 Starks Building, Louisville, Ky.

American Society for Testing Materials—The July 4 session of the next annual meeting, to be held at Atlantic City, has been abandoned. By this change the annual meeting will last from June 30 to July 3. As previously announced, the meeting will be held at the Hotel Traymore, Atlantic City, N. J.

The nominating committee has made the following nominations for the ensuing year: For President, A. W. Gibbs, Pennsylvania R.R.; for 2d Vice-President, A. A. Stevenson; for Secretary-Treasurer, Edgar Marburg. For members of Executive Committee, Robert Job, F. W. Kelley, A. Marston and S. S. Voorhees. Mr. Richard Moldenke holds over for another year as Vice-President, the term for that office being two years. Four directors also hold over.

The program just issued to the members shows that three meetings will be held on Tuesday, June 30, at 10 a.m., 3 and 8 p.m., respectively; two meetings on Wednesday at 10 a.m. and 8 p.m.; two meetings on Thursday and Friday at 10 a.m. and 3 p.m. The provisional program includes 66 miscellaneous items, which comprise the committee reports, individual papers, and business items. Among the more important papers to be presented are the following:

"Rational Tests for Metallic Protective Coatings," J. A. Capp.
"Proportioning Aggregates for Portland-Cement Concrete," Albert Moyer.
"Testing Concrete Aggregates," C. M. Chapman.
"Blast-Furnace Slag of Aggregate and Concrete," W. A. Aiken.
"Value of the Autoclave Test for Portland Cement," H. J. Force.
"Examinations of the Reasons for Concrete Failures," R. S. Greenman.
"Determination of Time of Setting of Cement," G. M. Williams.
"Volume Changes of Portland Cement and Concrete," Alfred H. White.
"Electrolysis of Portland Cement and Reinforced Concrete," H. J. Force.
"Strength of Lime Mortar," W. E. Emley and S. E. Young.
"Permeability Tests for Paints and Varnish," A. M. Muckenfuss and a number of others in discussion.
"Paint Protection for Portland-Cement Structures," Henry A. Gardner.
"Simple Compression Machine for Testing Structural Materials," W. O. Lichtner.

Engineering Literature

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CORRESPONDENCE

Pickels and Wiley on the Review of their "Railroad Surveying."

Sir—Your issue of April 16, 1914, contains a review of our "Text Book on Railroad Surveying." The review is so incomplete and the part actually reviewed froms such a minor part of the book, and the major part receives so little attention that the reader of the review is likely to be entirely misled as to the actual scope and content of the book.

A practicing engineer makes use of all available information, including his own experience, to make his work efficient. If existing designs are satisfactory he uses them, if not he makes new ones; but M. Lavis seems inclined to deny this right to the technical instructor, and to compel him to use existing material although it may be "practically out of date," and then probably complain that the instruction is inefficient. He evidently does not realize that the engineering teacher looks upon his work as an engineering problem and as such devotes the same energy to secure efficiency in his work as does the engineer in practice. Many of the books of which Mr. Lavis complains are the direct outgrowth of the notes, addenda and corrections which the instructor must perforce make to existing books in order to adapt them to his specific requirements.

After trying several texts on railway surveying and finding none of them satisfactory we were compelled to use several in combination in order to secure the matter desired. Obviously this is not conducive to efficiency and is unfair to the students in that they are compelled to buy several expensive books and use but little matter in each. With such conditions existing we did exactly what Mr. Lavis himself would probably have done under like conditions, viz., prepared a book containing just the matter which could be used in a modern uptodate course in railroad surveying.

Obviously the chief divisions of railroad surveying are curves, earthwork, and turnouts. To this we devote 80% of our book, but Mr. Lavis devotes only about one-fourth of his so called review to this part of the book, and gives practically nothing in the form of comments either adverse or favorable except an absurd remark about "growth" and "swell." Of the remaining 20% of the book about three-fourths is devoted to brief but (for our purpose) sufficient description of the various surveys and maps required in railroad work but Mr. Lavis utterly ignores this portion. This leaves less than 4% of the book to the subject of "economics" but Mr. Lavis takes up nearly half of his alotted space with criticisms of this part.

Mr. Lavis takes exception to the statement in the preface that it is thought that the book will appeal to practicing engineers, and his opinion to the contrary notwithstanding, we do. But by "practicing engineer" we do not refer to the man who will be placed at the head of the Alaskan Railway project but to "the man behind the gun," the man with the rod and tape, the man whose daily work is railroad surveying. In short the book is for the engineer on the right-of-way, not for the "engineer" in Wall Street.

In his last paragraph Mr. Lavis infers that there is nothing new in the book. So far as scientific knowledge is concerned this is undoubtedly true, but the treatment of an old subject is certainly radically different from that in other books, and decidedly more to the point for the purpose of instruction. Couple with this the fact that we have used only modern methods and eliminated entirely those which were almost obsolete in the days of Peter Cooper, and it would seem that the book could be credited with a little newness. From the standpoint of the student we have eliminated the mathematics (in detail) with which he is familiar, giving the solutions in outline only. This compels the student to analyze each problem and thus trains him how to attack new problems, rather than to simply hunt up a suitable formula (provided it can be found and he is able to recognize it). In our chapter on turnouts we have based all problems on the straight frog and switch as actually used on American railways, a method that has been conspicuous by its absence in most of the literature of the subject. In our chapter on Earthwork we have given a treatment of the "mass curve" and its uses, which, while by no means exhaustive, is of such a nature that the student can grasp the principles and make some use of them. These may not be new things to Mr. Lavis, and indeed are not new things to the experienced engineer, but they certainly are new from the standpoint of the beginner, and of the instructor.

Referring to the review as a whole, we are not objecting to the criticisms made by Mr. Lavis, nor do we take exception to the statements that he makes in regards to the economics of railroad location. In fact our objections to the review are based more on what he does not say than on what he does say.

If the consulting engineers would themselves give to the technical teacher books which are really worth while they would doubtless put an end to the waste of energy on the part of the teacher and at the same time would secure for themselves the undying gratitude of these same teachers.

PICKELS & WILEY.

Urbana, Ill., May 9, 1914.

Ancient Advice to Writers

He that taketh in hande to write any thing must first take heede that he be sufficient for the fame: for often vnwary fooles through their rashnes are ouertooke with great want of ability.

Let no man esteeme himselfe so learned, but that he may submytte hys wrytinges to the judgments of others, and correct and thoroughly amend the same himselfe.

A wryter must learne of the learned, and he must not sticke to confesse when he erreth; that the worse he may learn to auoyde, and knowe howe to follow the better.

The confession of an errour betokens a noble and a gentle minde. Celfus and Quintillian doo report of Hippocrates, that leart he should deceiue his posterity, he confessed certayne errours, as it well became an excellent minded man, and one of great credite. For (as sayth Celfus) light witts because they haue nothing, wyll haue nothing taken from them.

In making choice of such freendes as should tell vs the trueth, and correct our wrytinges, heedefull judgment must bee vsed; least eyther we choose vnskylfull folke, or flatterers, or dissemblers. The vnskylfull know not how to judge, flatterers feare to offende, dissemblers in not prayising doo seeme to commende.

Let no man deceiue himselfe, or suffer himselfe to be deceiued, but take some graue learned man to be judge of his dooing, and let him according to hys counsayle change and put out what hee thinketh good. [Extracts from Horace's "De Arte Poetica," as given in English in William Webbe's "A Discourse of English Poetrie." First printed in 1586.]

REVIEWS AND NOTES

Simple Steel Bridges

Reviewed by A. W. CARPENTER*

STEEL BRIDGE DESIGNING—By Melville B. Wells, Associate Professor of Bridge and Structural Engineering, Armour Institute of Technology. Chicago: The Myron C. Clark Publishing Co. London: E. & F. N. Spon, Ltd. Cloth; 6x9 in.; pp. vii + 260; 47 text figures; 26 folding plates. $2.50.

This book covers the usual ground of text-books on the subject of the design of simple, fixed spans for bridges and roofs. It opens with a chapter on "Engineers' Work and Contracts" which is distinctive. The familiar subjects of shop work, riveted joints, theory of strength of materials, types and details of construction, analysis of design of examples of trusses and girders, preparation of shop drawings and a bibliography are set forth in separate chapters. The American Railway Engineering Association's General Specifications for Steel Railway Bridges, 1910, are presented in full and a set of lithographic reproductions of detail drawings are grouped at the end of the book.

The chapter on "Engineers' Work and Contracts" gives a brief synopsis of the methods of surveying for a bridge location, the determination of type of bridge and length of span for a given location, and the usual scheme of plans and specifications for design and construction, including a description of the scheme of general specifications for design, manufacture and erection.

The chapter on "Bridge Manufacture" gives a concise and rather complete general description of the usual modern organization, equipment, process of manufacture and method of inspection for the fabrication of structural work, with illustrations of shop tools and shop arrangements. The theory of rivets and the practice of riveting are treated in a brief, though comprehensive manner, and with, perhaps, greater consideration given to practical conditions than usual.

The different types of structures treated are: Roof trusses, highway bridges and railroad bridges; the steps in the design of an example of a roof truss, a riveted-truss highway bridge, a through plate-girder, a riveted truss and a pin-connected truss railroad bridge being detailed. The work is generally in accordance with good practice and the treatment is concise and practical.

At the end of the chapter covering the analysis of the design of a plate-girder railroad bridge (where they seem to be rather misplaced), are inserted a number of tables giving the weight of steel in steel railway bridges and some formulas for weights of railway, highway and electric-railway bridges. These formulas should be used with a good deal of caution. The railway-bridge weights include the estimated or actual weights of bridges of three Western railroads for the ordinary types and span lengths; they are principally for single-track spans and include no floors carying more than one track. A table of weight of steel in single-track drawbridges of varying lengths for one of these roads is given, but as there is no separation of structural and machinery steel, and, indeed, it is not clear whether or not the machinery weights are included, the value of these weights is doubtful. The data on weights would be more easily located in the book if segregated in a separate chapter.

Under "Shop Drawings," rules and general considerations for the preparation of shop drawings, in accordance with standard practice, are set forth; under "Strength of Materials," the usual formulas for bending, shear, column strength, deflections of trusses, etc., with their derivations, are given. The bibliography covers a good assortment of books and articles on the subject. The lithographic reproductions of drawings consist of 26 pl[illegible] showing detailed designs and stress sheets. Twenty-t[illegible] of the plates are reproductions of drawings of the C., M. & St. P. R.R., and cover deck and through plate-girder spa[illegible] pony-truss span, a through riveted and a through pin-connected span and a viaduct.

The portion of the work devoted to the design of the different types of structures noted is contained in [illegible] pages, most of which are taken up by the explanations of the detailed designing of the examples selected, and it can therefore, be seen that the work is not at all exhaustive but is limited to a very few types and varieties of construction. Railroad bridges for single track only are considered and it seems a little unfortunate that the rather unusual details of the C. M. & St. P. Ry. designs, as regards top flanges of girders and some other features, should be set forth as examples of general types of construction without commenting on these features.

There is little or no attempt to go beyond the approximate methods for the determination of stresses and sections. The text portion of the book must, therefore, be considered as elementary and is probably to be commended on that account for the use of students; it is also to be commended on account of its general agreement with common practice. The plates will be found of value to the experienced designer as showing the carefully considered detail designs of a first class railroad bridge department.

*Assistant Valuation Engineer, New York Central & Hudson River R.R., Grand Central Terminal, New York City.

Molesworth's Twenty-Seventh Edition

MOLESWORTH'S POCKET-BOOK OF ENGINEERING FORMULAS—By Sir Guilford L. Molesworth, Past President, I. C. E., M. I. Mech. E., and Henry Bridges Molesworth, M. I. C. E. Twenty-seventh edition, revised and enlarged. With an Electrical Supplement by Walter H. Molesworth, M. I. E. E. and I. Mech. E. London: E. & F. N. Spon. New York: Spon & Chamberlain. Leatherette; 5x3 in.; pp. viii + 936; numerous illustrations. $2.

Fifty years have passed since the original Molesworth's pocket book appeared, but the work which found great favor at that time seems to have held its popularity. At any rate the twenty-seventh edition has been found advisable. Molesworth's remains the one true "pocket" book of wide scope. It contains a vast amount of fundamental data for civil, mechanical and electrical engineers but necessarily it is handicapped in any one of these fields by limitations of space which are not observed by the several "handbooks" which cover a more restricted field. There is a drawback for American readers in the use of British units and nomenclature; naturally British practice is treated largely though by no means exclusively.

As illustrative of the general scope of the book, some of the most important sections may be briefly run over. Certain parts apply to all branches of engineering—such as discussions of mathematical principles, conversion tables, etc. Under civil engineering would come the earthwork tables, tunnels and general excavations; walls, masonry and various framed structures; dimensions, construction and operation of railways and tramways; hydraulics—covering theory, pipes, weirs, irrigation, wave action, harbors, etc. Under mechanical engineering might be put the mechanics, physics, refrigeration, machine design, workshop receipts, steel furnaces, gas works, steam power, locomotives, waterwheels, turbines and pumps, marine architecture, gunnery, aëronautics. The electrical topics are grouped in a supplement; the range covers units, general theory (direct and alternating currents), properties of conductors, testing, dynamo-electric machinery, batteries, illumination, traction, etc.

THE MODERN GASOLINE AUTOMOBILE; Its Design, Construction, Maintenance and Repair—By Victor W. Page, Late Technical Editor of "The Automobile Journal"; author "The Modern Gas Tractor," "Automobile Questions and Answers," etc. 1914 Edition, revised and enlarged. New York: The Norman W. Henley Publishing Co. Cloth; 5x8 in.; pp. 816; 386 illustrations. $2.50.

In our issue of Feb. 13, 1913, we gave high praise to the edition of this book issued in 1913. It is significant of the rapid progress made in the development of the motor-vehicle industry that it should be deemed advisable within a year to radically revise so new and complete a work. Among the features which are covered by the added material incorporated in this edition, are cyclecars, farm tractors and plows, combination gasoline-electric drive systems, skew bevel gears new forms of worm-gear drive and with the two-speed direct-drive rear axle. A number of recently designed gasoline and

kerosene carburetors for various types of engines are also shown.

We heartily commend this book to any engineer who desires to understand the mechanism of the car which he owns or drives. The amount of mechanical and electrical apparatus with which a first-class automobile is today equipped is such that an engineer who thoroughly understands the whole machine in all its details, its principles of operations and the features of its design, can rank as a pretty good mechanical and electrical engineer.

Concrete Inspection

Reviewed by ERNEST McCULLOUGH*

A TREATISE ON THE INSPECTION OF CONCRETE CONSTRUCTION, Containing Practical Hints for Concrete Inspectors, Superintendents, and Others Engaged in the Construction of Public and Private Works—By Jerome Cochran, Jun. M. Am. Soc. C. E., author of "A Treatise on Cement Specifications" and "The Principles of Municipal Refuse Collection and Disposal." Chicago, Ill.: Myron C. Clark Publishing Co. Cloth; 6x9 in.; pp. xv + 595; 23 text illustrations. $4.

In the preface the author gives eight authorities and in the final chapter gives a list of sixty-five books and periodicals freely consulted in preparing his book. The result is a book which drags, in a not particularly interesting way, through 595 pages of material which should better have been put in 50 pages, using a somewhat larger type. The concrete industry would be better off if writers would not consult books written when concrete construction was beginning to assume importance. Those books had a place in their time, but during the past seven years so much work has been done and so many changes have occurred in men's ideas as well as in actual construction processes, that a majority of the books named by the author should be consigned to the scrap pile.

Considering the type of man usually appointed to inspect concrete work this book is valueless as a guide for inspection. Few inspectors are readers and this is a book for a student. The reviewer, however, would hardly give it to an inexperienced student for it contains much obsolete matter. The author does not give evidence of much familiarity with actual construction work, but does show that he has industriously collected and read a great deal of the literature on concrete which has flooded the market for several years.

River Dikes

Reviewed by E. KUICHLING†

BAU, UNTERHALTUNG UND VERTEIDIGUNG DER FLUSS-DEICHE—Von Ehlers, Geheimer Baurat, Professor an der Technischen Hochschule Danzig. Berlin: Wilhelm Ernst & Sohn. Paper; 7x10 in.; pp. 54; 54 illustrations. 3.20 Marks.

This booklet is the first of a series of articles on Hydraulic Engineering which are contemplated to be issued by the publishers. Its author has had extensive experience with the construction, maintenance and repair of dikes on the rivers Ill, Nogat, Vistula and Oder during the 18 years from 1887 to 1904 inclusive, in which some extraordinary floods occurred. It is designed to be useful to both engineers and the authorities in charge of dikes. After describing the functions of various kinds of dikes, the methods of designing, constructing and maintaining them are clearly described, and particular attention is given to modes of repair when breached by a flood. An abstract of the laws relating to such works in Prussia, Hanover and Schleswig-Holstein is appended. The booklet is well written and cannot fail to be highly valuable to those who are concerned with river hydraulics and the protection of lands against inundation.

THE MATHEMATICAL THEORY OF INVESTMENT—By Ernest Brown Skinner, Associate Professor of Mathematics in the University of Wisconsin. Boston, New York and London: Ginn & Co. Cloth; 6x9 in.; ix + 245; illustrated. $2.25.

The author found it necessary to develop a course of lectures in mathematics for the students of commerce and economics in the University of Wisconsin. The book in hand is a development and unification of these notes. It presents certain elementary mathematical procedures and develops their application to banking and common business finance. While the mathematical parts themselves will be very familiar to any engineer, being simple indeed to one who has traversed the calculus, yet the applications to interest, annuities, amortization, bond valuation, sinking funds, loan associations, and life insurance, will be interesting and helpful to anyone who has to consider such matters. An appendix gives some tables not commonly found in the engineers' text: (1) The number of the days of the year, (2) exact interest at 5% from 1 to 365 days (3) compound amounts on $1, (4) present values of $1, (5) annuities purchased by $1, (6) American experience table of mortality, etc.

INCANDESCENT ELECTRIC LAMPS AND THEIR APPLICATION—By Daniel H. Ogley, B. Eng. (1st Hons.) Liverpool; Later Rew. Research Scholar; Chief Assistant Lecturer in Electrical Engineering, the Royal Technical Institute, Salford. [Longman's Technical Handicraft Series.] New York and London: Longmans, Green & Co. Cloth; 5x8 in.; pp. x + 107; 59 text figures and illustrations. 80c. (2½ shillings), net.

The author has built up here a good little review of interior electric-lighting practice (with glow lamps) and the allied subjects of photometry and lamp manufacture. The text does not exhibit any great degree of novelty nor is it to be expected. There is some general matter on radiation, light propagation, illumination phenomena, the physiology of sight and the desirable characteristics of a lighting installation. Several photometric standards are described. Special attention has been given to a comparative presentation of the performance characteristics of carbon-, tantalum- and tungsten-filament lamps. This author, in common with many writers on such subjects, gives prismatic glass shades and reflectors much greater attention than other glass fittings available in a variety of forms; the difficulty of securing data on these other sorts only measures the usefulness of securing it even at some trouble. The author has a marked penchant for the "indirect" system (illumination by reflected light from ceilings) and well shows up the pleasing and useful features; he does not pay attention, however, to the care with which this scheme is to be employed where people have to live in such environment many hours every day. There are cases where the result was very pleasing at first, but complaints later arose from a disconcerting effect set up by its studied unusuality.

BUILDING BY A BUILDER; Practical and Economical Considerations for the Man About to Build—Benjamin A. Howes. Garden City and New York: Doubleday, Page & Co. Cloth; 5x8 in.; ix + 224; illustrated. $1.20, net.

In the words of the author, "This little book is addressed to the man who is about to build his own house for the first time. It does not seek to take the place of a popular manual, but aims to answer his first questions, to suggest to him the matters he ought to ponder and settle for himself, and the others on which he will need expert advice." The main chapter headings of interest are: How to Approach the Question of Building; Choosing Your House; The Unburnable House; Those Plans; From the Ground Up; Arteries of the House; Details and Their Values. From these headings, the conversational style of the book may be inferred.

Mr. Howes is a practical builder of wide experience, though, to be sure, his experience is chiefly in larger houses than the readers of his book will be apt to undertake. This predisposition toward the large house affects somewhat the nature of the advice given, but in spite of this there are many items which the small home owner can well appreciate, and which will serve admirably to instruct. It is good to see that Mr. Howes fully recognizes the impracticability of the so called "unburnable" house for the small owner. Too much of the current literature of building intimates that it is economical to incorporate in every minor dwelling all of those fine details of construction which the wealthy man can afford in his efforts to prevent the ravages of the fire fiend. On the other hand, we are afraid that the author will not be able to impress the ordinary reader with the comfort of living with stone or concrete or tile floors, stairways and sundry interior decorations he advocates in tone, if not in words. We recognize that this opinion classes us as hopelessly reactionary, but we mean to stick to it.

SLIDE-RULE NOTES—By Col. H. C. Dunlop, Late Professor of Gunnery, Ordnance College, Woolwich, and C. S. Jackson. New York and London: Longmans, Green & Co. [Longmans' Modern Mathematical Series.] Cloth; 5x8 in.; pp. 127; 58 text figures. 75c., net.

The present book is based upon a pamphlet of like name published by the same authors in 1911. The earlier material has been revised and a chapter on logarithmic scales

*Consulting Engineer, 1302 Monadnock Block, Chicago, Ill.
†52 Broadway, New York City.

added. The instructions apply almost exclusively to the 25-cm. rule designed by Colonel Mannheim. Numerous examples and problems are given with a list of answers. The book is well written and is businesslike.

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The Geometry of Ship Building

Reviewed by D. W. TAYLOR*

A TEXTBOOK OF LAYING OFF or the Geometry of Shipbuilding—By Edward L. Attwood, M. Inst. N. A., author of "Warships," "Theoretical Naval Architecture" and "The Modern Warship," and I. C. G. Cooper, Senior Loftsman of H. M. Dockyard, Chatham; Lecturer in Naval Architecture at Chatham; Lecturer in Ship Carpentry at Whitstable. New York and London: Longmans, Green & Co. Paper; 6x9 in.; pp. 119; 121 illustrations. $1.75, net.

In shipbuilding a mold (spelled always mould in Great Britain) is a pattern or template showing the shape or contour of a portion of a ship's structure. "Laying Off" is done upon the mold-loft floor, which is virtually a big horizontal blackboard upon which, when laying off, full sized drawings are made using the methods of descriptive geometry.

In the days of wooden shipbuilding there was done in the mold loft, if done at all, the work which in the present day would be done in the drafting room and planning office. Nowadays practice differs as to the distribution of work between the drawing office, the mold loft and the yard proper. Under one extreme of practice the mold loft is used only to determine needed shapes of the skeleton, as it were, of the ship, such as frames and beams, templates for plating being taken from the ship herself after the frames are erected in their proper place. Under an opposite extreme of practice the mold loft would be used to determine shape and rivet-hole locations for every part of the structure so that all work of fabrication could be done in advance of any erection.

A large American shipyard, organized originally by an engineer experienced in bridge building, probably comes closer to the latter extreme than any other yard now in existence and it is believed that in general greater use is made of the mold loft in American shipyards than is customary in English practice. The authors of this book point out, however, that at present, in England, there is a tendency to make greater use of the mold loft.

In this volume of 119 pages we find first a brief exposition of the elementary principles of descriptive geometry needed in mold-loft work, then after a description of a mold-loft floor and the drafting tools and appliances used on it, the authors take up in sucession the methods used in making the full-sized drawings upon the mold-loft floor, from the small-scale plans prepared by the designers, the preparation of the models upon which are drawn plans showing the plating, etc., and the preparation of the molds made from the full-sized plans upon the mold-loft floor. Then, after discussing several miscellaneous problems, the book closes with a series of examination questions on its subject and a brief, but excellent index.

Of the authors, Mr. Attwood, of the Royal Corps of Naval Constructors, is well known by his books on warships, and Mr. Cooper is in charge of the mold loft at one of the principal English shipyards.

The authors' joint production covers the subject very well indeed. To be sure, it is peculiarly one where practice in actually doing the work is essential to proficiency and there are many variants possible in the details of the methods for accomplishing a given result.

Students of naval architecture, however, will find this book ample as a repository of knowledge of mold-loft principles and methods.

The treatment of appendages, more common on naval than commercial vessels, such as shaft brackets and bilge keels, is particularly full. The 121 figures while small are clear and the frontispiece is an excellent view of an English mold loft.

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AMERICA'S TRIUMPH AT PANAMA; Panorama and Story of the Construction and Operation of the World's Giant Waterway from Ocean to Ocean—By Ralph Emmett Avery, author of "A Trip to Panama." Edited by William C. Haskins, of the "Canal Record." Chicago, Ill.: Regan Printing House. Cloth; 8x11 in.; pp. 384; profusely illustrated. $2.

Notwithstanding its rather flashy outside appearance this book contains a splendid collection of views of typical scenes on the Isthmus of Panama both before and during the American occupation. About two-thirds of the book is pictures, the other third contains apparently all the essential popular facts in regard to the country, its people and history, the canal building operations and the canal structures. The last chapter is a rather premature description of the two forthcoming Panama-Pacific World's Fairs at San Francisco and San Diego, Calif. The type is large and clear and the halftone work well done, so that the book as a whole serves as a very interesting souvenir of Panama.

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SHIPBUILDING FROM ITS BEGINNINGS—By E. Van Koninjenburg, Engineer of the Rijkswaterstaat of the Netherlands. 1895-1905. Brussels, Belgium: The Permanent International Association of Congresses of Navigation, Executive Committee, Office of the Secretary General 38 Rue de Louvain. Cardboard 13x19 in.; three volumes, pp. 107, 74 and 100; 427 illustrations.

This remarkable monograph on the evolution of the art of shipbuilding is at once a tribute to the great industry of its author and to the enterprise of the International Association which has undertaken its publication. Volume I contains the text of the monograph. It deals with the origin of shipbuilding studied in connection with the latest researches in ethnology and archaeology. It reviews the earliest ships of Greece, Phœnicia, and Egypt, while the illustrations very appropriately show a picture of Noah's Ark.

After this introductory chapter, dealing with the evolution of the shipbuilding art among primitive peoples and its development around the Mediterranean as a center, the author turns to the shipbuilding art as developed in the races surrounding the North Sea, and after giving some attention to the ancient Viking ships he turns to the vessels of Holland, to which hereafter his chief attention is devoted.

It is surprising to one who has not given attention to the subject to see the great variety of model and build which prevailed in the boats and ships of these early Dutch navigators. Vessels are described by the dozen, the names of which have never been heard of outside of Holland.

The work is popular rather than technical. The descriptions given of the different types of vessels are in general very brief and there is little concerning the evolution of the various mechanical processes in the shipbuilding art upon which the changes in models depended. Moreover the author brings his history only down to the middle of the last century; or, in other words, he confines his attention solely to vessels propelled by sails or oars and omits to follow the later developments since the application of steam to navigation. Of course, the work is therefore purely of historical or antiquarian value. It well deserves a place, however, in reference libraries where it will yield useful information to those curious to trace the origin of some of the names which survive to the present day, such as "yacht" and "scow," or to study the evolution of ships and their rigs.

One old vessel of special interest to engineers is the "Moddermolen" or dredge, the name of which translated into English is "Mud Mill." This vessel dates back to the early half of the 17th century and was of the endless chain or ladder type. It was driven at first by hand and later by horsepower. As late as 1829 the firm of Kater Bros. built a horsepower dredge which operated at a depth of 22 ft. requiring three to seven horses to run it. Those who are discouraged by the idea that the art of engineering has so developed that there is nothing more that engineers can do will be interested to read that in the 17th century these old Dutch "mud mills" were already so perfected, that it was imagined there was nothing else about them that could be improved."

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CEMENT, CONCRETE AND BRICKS—By Alfred B. Searle, Lecturer on Brickmaking Under the Cantor Bequest; Consulting Expert in the Cement and Clay Products Industries; author of "British Clays, Shales and Sands," "The Natural History of Clay," "Modern Brickmaking," "The Clayworker's Handbook," etc. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xi + 412; 113 illustrations. $3, net.

Mr. Searle is a lecturer on the cement and clay-products industry in Great Britain, and naturally his book is an epitome of English practice. Insofar as it is concerned with the material cement and its chemistry and production, it is an admirable text. When it comes to construction in concrete, it is, however, a very glossed over treatise. The section on bricks is quite good and should be of value to brick makers, though it has but little interest to engineers.

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BILL'S SCHOOL AND MINE: A Collection of Essays on Education—By William Suddards Franklin. South Bethlehem, Penn.: Franklin, MacNutt & Charles. Cloth; 5x7 in.; pp. vii + 98; illustrated. 50c. (Paper, 15c.)

A little sheaf of explosive essays—explosive only in style, of course, and shattering only to the peculiar minds of those who do not believe in country boys, city-school playgrounds,

*Naval Constructor, U. S. N., Navy Yard, Washington, D. C.

the school of shop, or the training of hard knocks. There are three major essays. The title essay is a plea for playgrounds. "The Study of Science" is a discussion of science study. The third essay presents some impressions of a tramp in Colorado and Wyoming. The five minor essays, as the author says, are "mere splashes" on work, play and school. The little volume is interesting to engineers as the odd-hour disputations of a well known teacher.

Mining Engineering

Reviewed by G. MONTAGUE BUTLER*

MINE SAMPLING AND VALUING: A Discussion of the Methods Used in Sampling and Valuing Ore Deposits with Especial Reference to the Work of Valuation by the Independent Engineer—By C. S. Herzig. With a Chapter on Sampling Placer Deposits by Chester Wells Purington. San Francisco: Mining and Scientific Press. London: The Mining Magazine. Cloth; 6x9 in.; pp. 163; 26 text figures. $2.

The author states in his introduction that he hopes this book "may serve as a guide to the young engineer and may not be without value to the more experienced and older men." This hope appears to be justified in so far as that portion of the work relating to the sampling of mines and placers is concerned, for it constitutes a practical, concise, explicit, and fairly exhaustive exposition of this topic. The author is, however, mistaken when he states that it is his opinion that "the methods of mine sampling are not taught in schools of mines," for courses in mine examinations and reports are offered in many first-class institutions—at least in this country; and this book may well be used in connection with such courses. It is to be feared, however, that the men who will benefit most from such a treatise are those self-styled mining engineers who consider that a mine expert need be little more than a mine sampler. It will indeed be unfortunate if Mr. Herzig's admirable effort should prove an aid to this class in helping them to that little knowledge which is so dangerous, and in making it easier for them to foist their services upon an unsuspecting public.

Mine sampling and mine valuation are, however, two quite different matters, and, although much useful information on the latter subject is presented, it is handled, on the whole, in a far less satisfactory manner than is sampling. This may be partly because the author believes that "the mining engineer is rarely an expert geologist and the geologist even more rarely a proficient mining engineer. The character of the work of each is different." The principal reason for the shortcomings of the book in this respect doubtless lies, however, in the fact that mine valuation cannot be done by rule, and cannot be taught by one book or a score of books. Experience, natural aptitude and common sense, as well as much geological and other technical knowledge, are needed for this work. If the end sought be merely the valuation of "proved" and "probable" ore, this book will point the way very satisfactorily; but the valuation of mines and, particularly, of prospects involves, unfortunately, the estimation of prospective ore as well; and geological knowledge is essential for this.

Where there is so much that is praiseworthy in a volume, it may seem captious to single out defects for special mention, but the classification of shale as a metamorphic rock on page 51 is so extraordinary as to deserve recording. In fact, the subdivision, on the same page, of all rocks into igneous, volcanic, sedimentary, dark colored basic eruptives, and metamorphics will astonish petrologists. Other errors of statement and typography are present, and are probably indicative of hasty preparation, but they detract little from the usefulness of a book that is deserving of much commendation.

THE LIFE WORK OF EDWARD A. MOSELEY IN THE SERVICE OF HUMANITY—By James Morgan. New York City: The Macmillan Co. Cloth; 6x9 in.; pp. ix + 378; 7 plates. $2, net.

So few biographies are written of men whose sole distinction is that they have been instrumental in solving some of the practical problems of everyday industrial life, that this book should be a welcome addition to our literature.

Its subject, Edward A. Moseley, was Secretary of the Interstate Commerce Commission from its organization in 1887 until his death in 1911. Perhaps his greatest work in this connection was the part he played in the enactment and enforcement of the laws safeguarding the lives of railway employees—the adoption of automatic couplings, air brakes and other safety appliances. As the author states, "the story needs to be told all the more because the general public knows so little of the labors of this government official who quietly turned what might have been a routine task into a noble service on behalf of his fellow men."

As this life is rather typical of a large class of faithful and little known public servants, among whom engineers are numerous, who form the governmental machinery for meeting and solving the practical problems of real life and are responsible for bringing about many of the improvements which make life happier and easier for large portions of the population—as this life is typical of the ordinary man—it should be read with interest by ordinary men.

Laboratory Power Testing

MECHANICAL LABORATORY METHODS: The Testing of Instruments and Machines in the Mechanical Engineering Laboratory and in Practice.—By Julian C. Smallwood, M. Am. Soc. M. E., Associate Professor of Experimental Engineering, Syracuse University. New York: D. Van Nostrand Co. Leather; 5x8 in.; pp. xiv + 333; 95 text illustrations. $2.50, net.

Author and publisher have evidently worked together in this case, and the result of their efforts is one of the few engineering books that give a distinct pleasure to handle. We had supposed that textbooks on testing had about exhausted the possibilities of originality, but the author has given us a decidedly new book. The printed page plays an important part—particularly in the technique of illustrations, every one of which is executed in the same style and excellence.

The text attempts to be no more than a brief treatise on the general principles behind mechanical-engineering (power) testing. Therefore it refrains from giving all possible methods of reaching a desired end or describing all possible appliances. It is conspicuously different from the few compendiums of apparatus and method which are, however good, confusing to the student. The actual theory and operation of power apparatus is not mentioned; the valuable testing codes of the American Society of Mechanical Engineers are not reprinted. All this is allowable as such matter is easily available and opportunity is given for a more free treatment of the subject.

The text opens with an unusually helpful and pertinent introduction on errors and accuracy, the "most probable" values of readings or graphs. The utility of curves is emphasized early. The text closes with a short dissertation on what an engineering report should cover and an outline of a scheme for conducting student tests.

The main body of the book has three general divisions: one on instrument testing, one on testing materials (fuels and products of combustion) and one on testing power units, such as engines, pumps, boilers, fans, compressors, turbines, etc. A student who covers all this ground will be possessed of a knowledge of the essential elements, though obviously with a very limited experience in the permutations and combinations of these elements which make up commercial practice. Each experiment laid out starts off with a statement labeled "principles" and then comes calibration (if it is an instrument under discussion) or the mapping out of the factors which have to be determined (if it is a power-unit test presented). Throughout, the author's style is concise, clear and readable. It is probably not possible to produce a book about which a few criticisms could not be made. This book has now and then a slip or a statement not made quite as well as the majority, but the points are few, minor, and so overshadowed by the general excellence of the work that they should not be detailed here.

ROCK EXCAVATING AND BLASTING—By J. J. Cosgrove, author of "Principles and Practice of Plumbing," "Sewage Purification and Disposal," "History of Sanitation," etc. Pittsburgh, Penn.: National Fire Proofing Co. Cloth; 5x8 in.; pp. 179; 72 illustrations. $2.50.

This is an admirable little discussion of the technic of rock excavating, and particularly of blasting. It takes up the methods of drilling, of charging the holes, and of firing, as well as the accompanying subjects of powder, dynamite, and the handling of explosives. Just why the National Fireproofing Co., which is the manufacturer of fireproofing materials for buildings, should undertake the publication of such a book, we do not know.

PROCEEDINGS OF THE THIRD INTERNATIONAL ROAD CONGRESS, London, 1913—Paris: Permanent International Association of Road Congresses, 1, Avenue d'Iena. Cloth; 6x9 in.; pp. 678; illustrated.

The report of the proceedings of this congress, prepared for "Engineering News" by Messrs. Nelson P. Lewis and E. L. Corthell, who were among the delegates to the congress, was published by us in July last, immediately after

*Associate Professor of Mining Engineering in Charge of Geology, Oregon School of Mines Corvallis, Oregon.

the Congress, which was held in London during the week beginning June 22. The volume contains a complete detail report of the proceedings of the congress, the excursions taken, etc., with a list of the members of the congress in all the countries of the world. The volume does not contain the papers and reports read at the meeting. These very bulky and voluminous papers were printed and distributed to the members in advance of the congress. The discussions which took place at the Congress, however, contain much material of interest to road engineers and as a matter of fact an engineer can get a great deal more information by the study of these verbatim reports of proceedings than he could have gained by attending the congress itself since the discussion there was carried on in various languages whereas here it is all translated into English.

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Guide for Electric-Railway Investors

ECONOMICS OF INTERURBAN RAILWAYS—By Louis E. Fischer, Consulting Engineer. New York and London: McGraw-Hill Book Co., Inc. Cloth; 5x8 in.; pp. ix + 116. $1.50.

It is a known fact that some interurban electric railways are fairly profitable, or at least are somewhat attractive as investments, while others are unprofitable and unattractive. There must be some common characteristic features of these two types, though it may require engineering experience to lay bare the distinguishing points, as the author has endeavored to do in this little volume.

Only "normal" interurbans are discussed—roads which enter important towns and cities, have heavy construction on easy grades and curves and over private rights of way, have good power facilities and modern rolling stock, operate at least hourly service, carry broken-package freight, and charge approximately 2c. per passenger mile base rate.

The peculiarities of the territory served are first discussed and the population immediately along the line is classified as "primary terminal" (in largest important city), "secondary terminal" (in smaller important cities), and "intermediate population" (in scattered towns, cities and villages). Tributary farming population is left out of account as the author holds that its effect is seen in the size and prosperity of the intermediate communities.

First, ten "typical" cases, taken at random, are presented to show that the percentage of express-freight revenue to gross earnings varies from 1 to 25% and therefore that "all the other than passenger revenue items are of such little consequence that the entire group of revenue may be considered together."

Statistics are shown for the operating revenues of 36 "typical normal" interurban lines in various parts of the country—giving miles of track, primary-terminal and intermediate-community population, and gross operating revenues. This discloses a probable earning of $7 to $13 per capita of intermediate town and village population where there is one important terminus only.

Similarly statistics are presented of 21 roads to show that where there is a secondary terminal and this is 40 miles or less from the principal city, the gross operating revenue is probably from $5 to $20 per capita of secondary-terminal

First, ten "typical" cases, taken at random, are presented terminus). This decreases 10% with each 10 miles increase of distance because of preference for steam trains.

Statistics for 20 roads showing revenue per car mile, give a variation of 18.86 to 38.26c., which the author states shows "utter lack of uniformity" and "futility of attempting to estimate revenue on this unit basis for electric railways." This particular argument is weakened, however, by differences almost equally great in per capita comparisons or any others that may be made.

Having thus found a way of estimating probable earnings from the character of contiguous territory, operating expenses are considered. Five subdivisions are made for their examinations and these follow the Interstate Commerce Commission accounting—(1) way and structures, (2) equipment, (3) traffic, (4) conducting transportation, (5) general and miscellaneous.

Statistics of the "typical roads," "selected at random," are taken to show the great variation of operating expense ($430 to $999 per track mile) and the much smaller expenditure than for steam roads ($1519 Av.)—all of which is interpreted as inadequacy of maintenance on most electric roads. The author works up an estimate of $800-$1000 per track mile for this item as to be expected.

For the "equipment" item, similar figures run from $357 to $790 per track mile and 1.93 to 2.85c. per car mile, while the author thinks $450-$600 or 3c. would be about the right allowance. The traffic organization expends in these same ten cases from $10 to $114 compared with $234 Av. for steam roads, and $50-$150 is recommended as advisable. The fourth item, including power and operation of cars, for the ten cases runs from $1562 to $3242 per track mile or 7.93 to 10.59c. per car mile; $1350-$1800 per mile or 9c. per car mile is recommended as an estimating allowance. The last item shows up on these ten roads at $315-$1893 per mile and 1.69-4.79c. per car mile; while $450-$800 and 3-4c. are recommended figures. Taxes are discussed; the same ten properties are burdened $96 to $357 per track mile and $250 is a recommended minimum to be figured against.

Estimates with figures for cost of construction are presented in detail and these sum up to $26,720-$38,650 per mile. After this the foregoing data are applied to several hypothetical cases which show some conditions under which a project seemingly would or would not be profitable.

In this way, the author has outlined a method of situation analysis which anyone able to invest would be able to follow. The principles are interesting and apparently sound from the engineering standpoint; the specific recommendations will probably be found in accord with the judgment of many other qualified engineers. However, the arguments and quoted data are not wholly convincing, for most engineers are wary of generalizing from such few data. For instance the author may have found from his experience that the 10 or 21 or 36 properties which he has quoted are typical of the several hundred roads of the country, but the ordinary engineer would like to examine the data, say from a hundred or two properties before feeling sure that any few taken at random really disclosed actual tendencies. Therefore the inclusion of studies of, say three to five times as many interurban electric roads would complete the impressiveness of the author's lessons though possibly it would not change one bit the figures set forth therein.

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BRITISH RAILWAYS; A Financial and Commercial Survey—By W. R. Lawson, Chairman of the Railway Shareholders' Association; author of "American Industrial Problems," "British Economics," "Modern Wars and War Taxes," etc. New York: D. Van Nostrand Co. Cloth; 5x8 in.; pp. xxxii + 320. $2, net.

Mr. Lawson's book deals with the railway system as a machine and a business and may be said to discuss its design and its operation in these two aspects. It gives a most interesting explanation of the railway business as conducted in Great Britain, with an insight into the special conditions affecting matters of policy and of practice.

One striking feature of the book is that it indicates a great similarity of conditions in Great Britain and the United States in regard to railway development and the problems of railway administration. Adverse legislation, public hostility, improper practice and short-sighted policy of managements and directors, rate agitations, labor troubles, competition and discrimination, improvements in equipment and service, increasing expenditures not compensated for by increasing earnings, increased stringency of government regulations, and a certain demand for government ownership and operation; all these have been among the prominent factors in the affairs of British railways as well as in those of American railways.

The first section of the book deals with the financial and legislative side of the question; the capitalization and cost of construction, the financial results of operation, and the systems of accounts and statistics, which systems are considered to be very unsatisfactory. The second section is a review of the history of railway development, with special chapters on electric railways and the enormous local traffic of London. The electric railways are nearly all rapid transit or suburban lines, there being no lines corresponding to the American type of electric interurban railway, but the author considers that electric traction will supersede steam traction.

As to the freight traffic entering London, it is of interest to know that a project for a belt line to intercept all the numerous main lines and give them direct communication with the docks district was defeated because each railway was afraid the others would get some advantage over it, and they preferred the present slow and costly method by which each handles its own traffic to its own terminals and then transfers the goods by street vehicles.

The third section deals with the freight and passenger service, and indicates that too great attention has been paid to improving passenger service rather than to the freight service, which is the revenue-producing traffic. The author describes the comprehensive system of prompt handling of freight which is a notable feature of English railway

operation, and shows that the American transfer or "transhipment" system has been introduced in order to consolidate separate shipments and secure full car loads. The freight service is generally criticized in many respects, however, and as an indication of conditions, we quote the author as follows:

Had our railway managers instead of wasting their time on problems of speed, long runs and drawing-room cars, devoted more of it to the economical movement of goods, they might toay have been thinking about reducing instead of raising freight rates. Cheap trains are far more needed for products than for producers.

The fourth section deals with rates and fares, giving many comparisons with American practice. The fifth section deals with administration. It includes some explanation of the many difficulties of operation due to labor troubles and the high-handed position of the unions. It gives also a brief comparative review of the railway systems of Great Britain, France, Germany and the United States. The sixth section discusses the political relations of the railways and the control exercised by the government and by various local authorities. The closing chapters deal with the nationalization or government ownership of the railways, to which the author is strongly opposed, stating that the railway system "owes its greatest virtues to private enterprise and its worst faults to the politicians."

The book is written well and in a manner that attracts attention, and it draws various comparisons between British and American practice.

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Lowering Ground-Water Level in Foundation Works by Driven Wells

Reviewed by E. KUICHLING*

GRUNDWASSERABSENKUNG BEI FUNDIERUNGSARBEITEN—Von Dr.-Ing. Wilhelm Kyrieleis. Berlin: Julius Springer. Paper; 7x10 in.; pp. vii + 191; 80 text figures. 6 Marks.

This book deals with the lowering of the ground-water level by means of driven wells during foundation operations, and incidentally it gives the theories of Darcy, Lueger, Forchheimer, Dupuit, Thiem and Piefke in regard to the motion of water through permeable soils, together with a brief summary of the European literature on the subject. The author states that the method was first described by Salbach in 1874 in his report on the water-works of Dresden, but remarks that it was applied in 1870 in preparing the foundations of a theater in Oldenburg. It was next used by Thiem in 1886 at Leipsic, and has since been adopted successfully in many important undertakings.

In the second section of the book, the possibility of estimating in advance the capacity and efficiency of a plant of driven wells is discussed, and the various preliminary examinations and tests for the purpose are clearly set forth. The third section gives a good description of a number of cases in Germany where the method was applied, and a comparison of the actual results with the theoretical assumptions. The fourth section relates to the necessary equipment of a plant with tubular wells, suction and discharge pipes, pumping machinery and motive power, but unfortunately it is lacking in illustrations of structural details.

The book presents the subject in a very interesting manner and will form a valuable addition to the technical literature of ground-water.

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MONARCHICAL SOCIALISM IN GERMANY—By Elmer Roberts. New York: Charles Scribner's Sons. Cloth; 5x8 in.; pp. 200. $1.25, net.

State and municipal ownership of railways and other public utilities, lands, forests and mines, the adjustment of railway freight rates in aid of domestic industry and foreign commerce, government encouragement of syndicates, industrial education, labor exchanges, insurance against unemployment, and taxation of the unearned increment of land values are the main topics considered in this interesting and readable book.

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THE ENGINEERING INDEX ANNUAL FOR 1913—Compiled from the Engineering Index published monthly in "The Engineering Magazine." New York: The Engineering Magazine Co., 140 Nassau St. Cloth; 7x10 in.; pp. 510. $2.

Atfer several weeks' use the reviewer is able to say that this volume of the Index is the best that has appeared since 1906, when the present method of broad classifications was adopted. To obviate the difficulties in deciding under what heading to look for a particular article the editors have included a very full and complete classification, which gives not only main and sub-heads, but lists of catchwords which greatly facilitate the work of the searcher. If this list is consulted and studied by the user of the book, as it should be, the chief objections to the scheme of broad classifications are overcome. Important articles in about 250 periodicals are indexed, and in most instances the entries are sufficiently full to give the searcher a very good idea of the character of the article. The volume is the same size as the series previous to 1913. The 1912 volume for some reason or other was made about a half inch higher than the series up to that time.

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Cableways

Reviewed by WINSLOW H. HERSCHEL*

DIE DRAHTSEILBAHNEN IHR AUFBAU UND IHRE VERWENDUNG—Von Dipl.-Ing. P. Stephan. Second edition, revised. Berlin: Julius Springer. Cloth; 7x10 in.; pp. iv + 288; 286 illustrations. 9 Marks.

Under the above title one might fail to recognize a new edition of "Die Luftseilbahnen," a book of 193 pages which appeared in 1907. With the idea that comparatively few firms are interested in building cableways, the author writes more for the benefit of the purchaser than of the designer.

Chapter III gives particulars concerning rope and towers, and general plans of terminals, but the subject of operating machinery is not considered. In order to avoid a criticism made in regard to the first edition—that some manufacturers were mentioned oftener than others—the author now confines his attention entirely to the products of A. Bleichert & Co., with the exception of primitive cableways described by way of introduction and one or two not altogether complimentary references to American installations.

The aërial cable tramways in mountainous regions, with grades up to 100% and single spans up to 3000 ft. long, show the possibilities of cableways in regions where any form of railway would be out of the question. More familiar uses of cableways, of which many examples are given, are to connect factories with wharves or railroads, and for use in mines, power houses and loading and unloading ships. There is no mention of the American device of coaling ships at sea, nor of any equivalent. Inside of buildings the cable is often replaced by a rail, but such suspended railways are naturally enough included in a description of cableways. Temporary cableways, such as are used at bridges and dam sites, are called cable cranes, a name that would very well apply to many of the devices shown for unloading ships.

The concluding chapters take up cost of operation, erection and cableways for transportation of passengers. The cost of transporting freight is shown to be considerably lower than by rail, especially where traffic is small. Ordinarily erection presents no serious difficulties, but it may be expensive in mountainous regions where tunnels are necessary, as not infrequently occurs, one in Argentine being 1000 ft. long. In considering the transportation of tourists, it is evident that the cableway that carries a passenger to the top of the Wetterhorn in the open air is preferable to the railroad up the Jungfrau which is entirely in tunnel.

While the book would be disappointing to a designer, it seems well adapted for its main purpose of presenting to a prospective purchaser a large number of descriptions of cableways actually installed, so as to enable him to form an idea of the adaptability of a cableway to his especial needs.

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THE OFFICIAL GOOD ROADS YEAR BOOK OF THE UNITED STATES, 1914—Washington, D. C.: American Highway Association, Colorado Building. Cloth; 6x9 in.; pp. 501. $1.

Needless to say to those familiar with the previous issues of this year book, it contains a very valuable compilation of data for everyone connected with or interested in any way in the improvement of highways. The chapter on State Aid Legislation to Jan. 1, 1914, is particularly valuable as during the past year much progress has been made in improving state highway organizations—in Maine, Illinois, Iowa and Minnesota especially. Another feature which is practically worth the cost of the book is the bibliography on road, bridge and culvert construction and allied subjects. Of particular value to engineers and contractors is the compilation of road funds available for 1914. Other chapters on the history of road building, types of roads, dust preventives, highway bridges and culverts, state and United States progress reports, etc., are similar to those in previous editions. A chapter on the Massachusetts specifications for state highways is valuable for reference as Massachusetts has long been considered to possess some of the best highway engineering talent.

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*52 Broadway, New York City.

*Assistant Physicist, Bureau of Standards, Washington, D. C.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

CEMENT-VERARBEITUNG: Part 5, Cementrohre; Part 6, Die Verarbeitung der Baustoffe im Beton- und Eisenbetonbau—Edited by Regierungsbaumeister a. D. Riepert, Vorstand der Centralstelle zur Förderung der Deutschen Portland-Cement-Industrie. Charlottenburg, Germany; Cementverlag G. m. b. H., Knesebeckstr. 74. Paper; 6x9 in.; pp. 41 and 53; 36 and 59 illustrations. 35 Pfennig, each.

COLORADO SCIENTIFIC SOCIETY—(Denver, Colo.): Report of the Executive Secretary for 1913: Report of the Treasurer for Year Ended Dec. 20, 1913; Systematic Testing in the Evolution of Mill-Practice. By George E. Collins. [Proceedings of the Society, Vol. X, pp. 431-452. Reports xv-xxii.] Paper; 6x9 in.; pp. 451.

COMPRESSED AIR: A Treatise on the Production, Transmission and Use of Compressed Air—By Theodore Simons, M. Am. Inst. M. E., Professor of Mining Engineering, Montana State School of Mines. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xi + 173; 42 illustrations. $1.50, net.

CONNECTICUT PUBLIC UTILITIES COMMISSION — (Hartford): Second Annual Report, including the Financial Reports of All Public Service Companies for the Year Ending June 30, 1913, with Statistical Tables Relating Thereto. Cloth; 6x9 in.; pp. 663.

DESCRIPTIVE GEOMETRY: Part I, Lines and Planes—By John C. Tracy, Assistant Professor of Structural Engineering, Sheffield Scientific School, Yale University. Part II, Solids—By Herbert B. North, Assistant Professor of Drawing and Descriptive Geometry, Sheffield Scientific School, Yale University, and John C. Tracy. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 10x8 in.; pp. x + 126; illustrated. $2, net.

DESIGN AND CONSTRUCTION IN WOOD—By William Noyes, Assistant Professor of Industrial Arts, Teachers College, Columbia University, Peoria, Ill. The Manual Arts Press. Cloth; 6x9 in.; pp. 159; 204 illustrations. $1.50.

DESIGNING AND DETAILING OF SIMPLE STEEL STRUCTURES—By Clyde T. Morris, M. Am. Soc. C. E., Professor of Structural Engineering, Ohio State University. Third edition, revised and reset. New York and London: McGraw-Hill Publishing Co., Inc. Cloth; 6x9 in.; pp. xi + 260; 94 illustrations. $2.25, net.

DIRECTORY OF BOILER, TANK AND STACK MANUFACTURERS of the United States and Canada—Brooklyn, N. Y. (The Continental Iron Works): F. B. Slocum, Secretary Supplymen's Association of the American Boiler Manufacturers Association of the United States and Canada. Paper; 6x9 in.

Gives names of hundreds of manufacturers. The states are aranged alphabetically and then the manufacturers are listed under cities, also arranged alphabetically.

DISEASE-BEARING MOSQUITOES OF NORTH AND CENTRAL AMERICA, THE WEST INDIES AND THE PHILIPPINE ISLANDS—By C. S. Ludlow, Anatomist, Army Medical Museum. Washington, D. C.: War Department, Office of the Surgeon-General. Bulletin 4. Paper; 6x9 in.; pp. 97; illustrated.

FACTORY ADMINISTRATION AND ACCOUNTS: A Book of Reference with Tables and Specimen Forms, for Managers, Engineers and Accountants—By Edward T. Elboure, Department Works Manager to the Birmingham Small Arms Co., Ltd. With Contributions on "The General Problem of Industrial Works Design," by Andrew Home-Morton, M. Inst. C. E., Of Home-Morton, Ker & Gibson, and "Financial Acounts," by John Maughfling, Secretary to I. Thornycroft & Co., Ltd. New York and London: Longmans, Green & Co. Cloth; 7x10 in.; pp. xv + 638; illustrated. $7.50, net.

FOREST PRODUCTS: LUMBER, LATH AND SHINGLES, 1912—Washington, D. C.: Bureau of the Census. Paper; 6x9 in.; pp. 60; illustrated.

FOUNDATIONS OF BRIDGES AND BUILDINGS—By Henry S. Jacoby, Professor of Bridge Engineering, Cornell University, and Roland P. Davis, Professor of Structural and Hydraulic Engineering, West Virginia University. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xvi + 603; 205 text illustrations. $5, net.

HARPER'S AIRCRAFT BOOK: Why Aëroplanes Fly, How to Make Models and All About Aircraft, Little and Big—By A. Hyatt Verrill, author "Harper's Book for Young Naturalists." New York and London: Harper & Brothers. Cloth; 5x8 in.; pp. xv + 245; illustrated. $1, net.

HARPER'S GASOLINE ENGINE BOOK: How the Engine Is Made, How to Use It at Home, in Boats and Vehicles and Elsewhere, and How to Keep It in Order—By A. Hyatt Verrill, author of "Harper's Wireless Book." New York and London: Harper & Brothers. Cloth; 5x8 in.; pp. xx + 292; illustrated. $1, net.

HEAT—Prepared in the Extension Division of the University of Wisconsin by E. M. Shealy, Assistant Professor of Steam Engineering, University of Wisconsin. [Engineering Education Series.] New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xi + 262; text illustrations. $2, net.

ILLINOIS PUBLIC UTILITY COMMISSION LAW AND MUNICIPAL OWNERSHIP LAW, With Annotations, Original Notes and Index-Digest—By William J. Norton, Secretary of the Rate Research Committee of the National Electric Light Association. Chicago: T. H. Flood & Co., 214 W. Madison St., and Electrical Review Publishing Co., 608 So. Dearborn St. Linen; 8x11 in.; pp. 200. $2, postpaid.

ILLINOIS WATER SUPPLY ASSOCIATION—Proceedings of Meeting, March 9-11, 1914. Urbana, Ill.: Edward Bartow, Secretary. Cloth; 6x9 in.; pp. 243; illustrated.

Special commendation is due the officers of the Association for publication of these Proceedings within about six weeks of the date of the convention.

KURZE PRAKTISCHE GEOMETRIE (VERMESSUNGSKUNDE) Für Vorarbeiten von Verkehrs- und Ähnlichen Anlagen—Von Vincenz Pollack. Vienna, Berlin and London: Verlag für Fachliteratur G. M. B. H. Cloth; 12x18 in.; pp. 258, 220 text illustrations. 24 kronen.

MASSACHUSETTS BOARD OF HARBOR AND LAND COMMISSIONERS—Annual Report for 1913 — Boston: Frederick N. Wales, Clerk of Board, State House. Cloth; 6x9 in.; pp. 225.

THE MICROSCOPY OF DRINKING WATER—By George Chandler Whipple, Gordon McKay Professor of Sanitary Engineering, Harvard University and the Massachusetts Institute of Technology. With a Chapter on "The Use of the Microscope," by John W. M. Bunker. Third edition, rewritten and enlarged. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xxi + 409; 73 illustrations; 25 plates. $4, net.

MOLDED ELECTRICAL INSULATION AND PLASTICS—By Emile Hemming. New York: Ward Clausen Co. Cloth; 5x8 in.; pp. 207; 36 plates and text figures. $3.

THE NAVAL POCKET-BOOK, 1914—Founded by Sir W Laird Clowes. Edited by R. C. Anderson. London, England: W. Thacker & Co. Cloth; 4x6 in.; pp. xxix + 717; illustrated. 7½ shillings, net.

THE PANAMA CANAL—By Frederic J. Haskin, author of "The American Government," etc. Garden City and New York: Doubleday, Page & Co. Cloth; 5x8 in.; pp. x + 386; illustrated. $1.35, net.

A PRACTICAL TREATISE ON SUB-AQUEOUS FOUNDATIONS, Including the Coffer-Dam Process for Piers and Dredges and Dredging, With Practical Examples from Actual Work—By Charles Evan Fowler, M. Am. Soc. C. E., Special Lecturer, University of Washington. Third edition, revised and enlarged. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xiiii + 814; 477 illustrations. $7.50, net.

PREPARATION OF METALLIC COBALT BY REDUCTION OF THE OXIDE, Part I—By H. T. Kalmus and Others. Ottawa: Canadian Department of Mines. Paper; 7x10 in.; pp. 36.

REGULATION OF PUBLIC SERVICE COMPANIES IN GREAT BRITAIN, With Supplemental Chapters on the Boston Sliding Scale and Toronto Auction Sale and Maximum Dividend Plans—By Robert H. Whitten, Librarian-Statistician, Public Service Commission for the First District, State of New York (154 Nassau St., New York City). [Reprint of Appendix G, Annual Report of the Commission for 1913.] Paper; 6x9 in.; pp. 231.

REPORT ON PROPOSED WATER SUPPLY FOR THE RICHMOND (CALIF.) MUNICIPAL WATER DISTRICT — By Haviland, Dozier & Tibbetts, Alaska Commercial Bldg., San Francisco, Calif. Paper; 6x9 in.; pp. 211.

STEAM PIPES: THEIR CONSTRUCTION AND ARRANGEMENT—Manchester, England: Vulcan Boiler and General Insurance Co., Ltd., 67 King St. Linen; 6x9 in.; pp. 108; 62 illustrations. 1 Shilling, net.

STEAM TURBINE: A Practical and Theoretical Treatise for Engineers and Designers, Including a Discussion of the Gas Turbine—By James Ambrose Moyer, M. Am. Soc. M. E., Professor in Charge of Department of Mechanical Engineering, Pennsylvania State College. Second edition, revised and enlarged. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xi + 376; 225 illustrations. $3.50, net.

TECHNISCHE MECHANIK; Ein Lehrbuch der Statik und Dynamik für Maschinen- und Bauingenieure—By Prof. Dr. Ing. Max Ensslin, Stuttgart. Being second edition; first edition by Ed. Autenrieth. Berlin: Julius Springer. Cloth; 6x9 in.; pp. xxiv + 634; 297 illustrations. 18 Marks.

A TREATISE ON THE LAW OF PUBLIC UTILITIES OPERATING IN CITIES AND TOWNS—By Oscar L. Pond, Member of the Indianapolis Bar; author of "Municipal Control of Public Utilities." Indianapolis, Ind.: The Bobbs-Merrill Co. Cloth; 6x9 in.; pp. lvi + 954. $6.

DIE VIRTUELLEN LAGEN DER EISENBAHNEN: Die Vergleichslängen im Allgemeinen. Die Methoden der verschiedenen Autoren zur Bestimmung virtueller Entfernungen. Die virtuelle Länge hinsichtlich der Transportkosten, sowie der Transport und Bahndienstkosten im Besondern, die Beziehungen derselben zu andern Vergleichslängen und ihre allgemeine Anwendung—Von Dr. sc. techn. Carl Mutzner, Ingenieur. Zurich and Leipzig: Leemann & Co. Paper; 7x10 in.; pp. 173; illustrated. 6 Francs.

WORKMEN'S COMPENSATION LAWS OF THE UNITED STATES AND FOREIGN COUNTRIES—Washington, D. C.: Bureau of Labor Statistics. Whole No. 126. Paper; 6x9 in.; pp. 477.